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AN EXAMINATION OF SEVERAL COMMERCIAL SPECIMENS OF OPIUM ALKALOIDS OR THEIR SALTS.*

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For several years the question of the synergistic effects of drugs has attracted considerable attention, particularly in connection with the several alkaloids of opium. Although about twenty-five alkaloids have been isolated from opium, the quantities in which most of the "minor alkaloids" exist in that drug are so minute that most of the pharmacologic experiments in synergism have been carried out with the alkaloids which occur in the largest amounts;[1] *i.e.*, with morphine, narcotine, papaverine, thebaine, codeine, and narceine.

Dr. D. I. Macht, of the Department of Pharmacology of Johns Hopkins University, has conducted pharmacologic studies[2] on some of the opium alkaloids. This work was carried out under a grant from the Committee on Therapeutic Research of the Council on Pharmacy and Chemistry of the American Medical Association. In view of the fact that the Laboratory of the American Medical Association has often shown that little-used drugs are likely to be of poor quality,[3] it was thought best to examine the material used by Dr. Macht for identity and purity.

* Contribution from the Chemical Laboratory of the American Medical Association.

[1] According to Henry ("The Plant Alkaloids," 1913, p. 199), the opium which is used in America and Europe is almost wholly of the Asia Minor variety (Smyrna opium). The names and formulæ of the opium bases and the approximate amounts in which they occur in Smyrna opium are given in Appendix 1.

[2] *Jour. Am. Med. Assn.*, 64, 477 and 1489 (1915).

[3] Unofficial Preparations of Hydrastis (Golden Seal), Rep. Chem. Lab., A. M. A., 1, 23, (1908). Examination of Tablets of Bismuth, Opium and Phenol, Rep. Chem. Lab., A. M. A., 1, 28 (1908). Zinc Permanganate, Rep.

The specimens examined were codeine phosphate, morphine sulphate, narceine, narcotine, narcotine hydrochloride, papaverine hydrochloride, and thebaine hydrochloride. Dr. Macht stated that all of the material was of the Merck brand except one specimen of morphine sulphate, one specimen of narcotine, and a specimen of papaverine hydrochloride.[4] These were products bearing the labels, respectively, of Eimer & Amend, the Mallinckrodt Chemical Works, and the Hoffmann-LaRoche Chemical Works.

With the exception of codeine phosphate and morphine sulphate, which are described in the U. S. Pharmacopœia,[5] the tests for the purity of the opium bases or their salts are not described in the literature with sufficient exactness to be of much use in determining the purity of commercial products. Therefore it became necessary to compile or devise tests by which the identity and purity of the specimens sent could be judged. Accordingly preliminary tests were prepared which were based upon published information. These were amplified and modified as found necessary by the results obtained in the examination as the work progressed. As the quantities of material sent by Dr. Macht were small, most of the preliminary tests were carried out on specimens purchased from the same wholesale druggist from whom Dr. Macht had obtained his supplies. In so far as it was possible to obtain them, the purchased specimens were of the same brands as were used by Dr. Macht. One specimen of narcotine which was stated by Dr. Macht not to be a market preparation, but to have been prepared by the manufacturer for research purposes, was not duplicated. Also a second specimen of thebaine hydrochloride could be obtained.

The tests to which the specimens of narceine, narcotine, narcotine hydrochloride, papaverine hydrochloride, and thebaine hydrochloride were subjected were adapted and devised, for the most part, from published information concerning the properties of the respective substances; the properties of such other substances as seemed likely to be present as impurities were also taken into account.

Chem. Lab., A. M. A., **2**, 15 (1909). The Composition of Commercial Copper Citrate, Rep. Chem. Lab., A. M. A., **3**, 27 (1910). The Composition of Strychnine Arsenate, Rep. Chem. Lab., A. M. A., **3**, 35 (1910). Aromatic Digestive Tablets, Rep. Chem. Lab., A. M. A., **3**, 64 (1910).

[4] An additional specimen of papaverine hydrochloride bearing the Merck label was examined later and the results are included in this report. This brand of papaverine hydrochloride was not used by Dr. Macht.

[5] Pharmacopœia of the United States, 8th rev., pp. 109 and 295.

Codeine Phosphate.

The tests to which the specimens of codeine phosphate were subjected were essentially those which will probably be described in the ninth revision of the U. S. Pharmacopœia.[6] In addition, phosphate was determined in the solution from which the codeine had been removed, by precipitation as ammonium magnesium phosphate, heating and weighing as magnesium pyrophosphate.

The results obtained in the examination are given below.

The specimen of codeine phosphate was a fine, white powder which under the microscope was seen to be considerably effloresced. It dissolved in water, leaving not more than traces of insoluble matter. The specimen was free from chlorides, sulphates, meconates, cryptopine, thebaine, and morphine. A purchased specimen of codeine phosphate appeared to be of as good quality as the one sent by Dr. Macht. It was not effloresced to such a great extent. The findings for the two specimens are given in Table I.

Table I.

Composition of Two Specimens of Commercial Codeine Phosphate.

	Merck	Merck*	Theory
Water (loss at 100°)	2.68	8.61[a]	8.31[b]
Alkaloid	74.13	70.15	69.06
Phosphoric acid (H_3PO_4)	23.75	22.90	22.63
Melting-point of isolated alkaloid	155.3° (corr.)	155.7° (corr.)	154 to 156°

* Purchased specimen.

a, *b*. Codeine phosphate crystallized with two molecules of water of hydration contains 8.31 per cent. of water of hydration; with one and one-half molecule, 6.36 per cent.

Codeine phosphate was first studied by Anderson,[7] who obtained it containing one and one-half molecules of water of hydration. It was pointed out by Schmidt,[8] a number of years ago, that commercial codeine phosphate was of variable composition. Depending upon the method of preparation, it might contain one-half, one and one-half, or two molecules of water of hydration. Schmidt states that codeine phosphate effloresces rapidly at ordinary temperature, losing all but one-half molecule of its water of hydration. He contends that in the interest of stability and uniform dosage the salt having the latter composition should be officialized.

[6] *Jour. Am. Pharm. Assoc.*, **2**, 1389 (1913).

[7] *Annal. Chem. Pharm.*, **77**, 352 (1851).

[8] *Apoth. Ztg.*, **5**, 366 (1890).

The U. S. Pharmacopœia (VIII) describes codeine phosphate as containing two molecules of water of hydration, but states that the salt frequently crystallizes with one and one-half molecules of water of hydration.

Morphine Sulphate.

The tests to which the specimens of morphine sulphate were subjected were essentially those which will probably be described in the ninth revision of the U. S. Pharmacopœia.[9] In addition, sulphate was determined by precipitation with barium chloride, collection of the barium sulphate, heating and weighing in the usual way. Codeine sulphate was calculated from the amount of codeine as determined.

The results obtained in the examination are given below.

Two specimens of morphine sulphate were received from Dr. Macht and examined. Each was a yellowish-white, crystalline powder which dissolved in water to a pale yellow, neutral solution, leaving not more than traces of insoluble matter. Each specimen was free from ammonium salts, chlorides, cryptopine, meconates, narcotine, and thebaine. Each specimen contained small quantities of a codeine salt.

The specimens were compared with a purchased specimen of morphine sulphate. Each was considerably darker in color than the one purchased, and the solution of each in water was considerably darker. The specimens sent contained less codeine than the specimen purchased. The analytical results were also compared with those obtained from a specimen of morphine sulphate of another brand (Powers-Weightman-Rosengarten) which was known to be several years old. The analytical findings are given in Table II.

Table II.

Composition of Some Specimens of Commercial Morphine Sulphate.

	Merck	Eimer & Amend	Merck*	P.-W.-R.†	Theory
Water (loss at 100° in vacuum)	11.22	11.59	11.11	11.03	11.88
Sulphuric acid (H_2SO_4)	13.15	12.99	13.03	12.99	12.93
Codeine (anhydrous alkaloid)	0.41[a]	0.58[b]	1.26[c]	2.41[d]	0
Morphine (anhydrous alkaloid, by difference)	75.22	74.84	74.60	73.57	75.19

* Purchased specimen.
† Purchased specimen; known to be several years old.
[a] Equivalent to 0.54 per cent. of crystallized codeine sulphate.
[b] Equivalent to 0.76 per cent. of crystallized codeine sulphate.
[c] Equivalent to 1.65 per cent. of crystallized codeine sulphate.
[d] Equivalent to 3.17 per cent. of crystallized codeine sulphate.

[9] *Jour. Am. Pharm. Assoc.*, **2**, 1397 (1913).

The results of the examination show that the chief impurity in the specimens of morphine sulphate examined is codeine sulphate. The presence of codeine in the market supply of morphine sulphate has repeatedly been shown.[10] Up to 7 per cent. has been reported, but the amounts usually found are less than 3 per cent. The ninth revision of the U. S. Pharmacopœia [11] will probably provide a test for the presence of codeine sulphate in morphine sulphate which will limit the permitted amount to not more than about 1 per cent. of the foreign salt. The specimens sent by Dr. Macht conform to this standard.

In addition to the tests proposed for inclusion in the ninth revision of the U. S. Pharmacopœia, very few experiments were carried out with morphine sulphate. The optical activity of one of the specimens was observed and was found not to agree with the published values. For example, Henry [12] gives the specific rotatory power of the salt as $-100.47°$ in water at 15° C. The value found for the purchased specimen of the salt (Merck brand) was $-93.44°$, or about 93 per cent. of theory. The specific rotatory power of another purchased specimen of the salt (P.-W.-R. brand known to be several years old) was found to be $-94.07°$. The former of these contained about 1.65 per cent. of codeine sulphate and the latter about 3.17 per cent., but, as the specific rotatory power of crystallized codeine sulphate is stated [13] to be $-101.2°$ at 15° C. the discrepancy noted in the morphine salt can scarcely be explained on the ground of the presence of this impurity.

Narceine.

In addition to tests for identity, the tests applied to the specimens of narceine included determinations of water of hydration (loss at 100° C.), chloride, and melting-point. Limit tests were carried out for meconates, sulphates, codeine, morphine, narcotine, and papaverine. Codeine, narcotine, and papaverine were tested for by dis-

[10] Williams, Am. Jour. Pharm., **84**, 391 (1912). Kebler, *Ibid.*, 501. Williams, *Jour. Am. Pharm. Assoc.*, **2**, 81 (1913). Kebler, *Jour. Am. Pharm. Assoc.*, **1**, 1405 (1912). Kebler, *Proc. Assoc. Off. Agric. Chem.*, **29**, 192 (1913). Wilson, Ann. Rep. U. S. Dept. Agric. (1912). E'We and Vanderkleed, *Jour. Am. Pharm. Assoc.*, **2**, 981 (1913).

[11] *Jour. Am. Pharm. Assoc.*, **2**, 1897 (1913).

[12] "The Plant Alkaloids," p. 211.

[13] *Ibid.*, p. 214.

solving the alkaloid in potassium hydroxide solution, extracting the solution with ether, and testing the residue on evaporation for the respective alkaloids.

The results obtained in the examination of the specimen of narceine are given below.

Grayish-white powder which under the microscope was seen to be considerably effloresced. The preparation was free from sulphates, meconates, narcotine, codeine, and morphine, but contained considerable quantities of a chloride, evidently narceine hydrochloride. The findings were compared with those obtained from the examination of a purchased specimen. The two specimens were not markedly different. The analytical findings for the specimens are given in Table III.

TABLE III.

Composition of Two Specimens of Commercial Narceine.

	Merck	Merck *	Theory $C_{23}H_{27}O_9N.3H_2O$
Water (loss at 100°)	6.32	6.13	10.81
Hydrochloric acid (HCl)	1.20[a]	0.98[b]	0
Alkaloid (by difference)	92.48	92.89	89.19
Melting-point (undried specimen)	165° (corr.)	165° (corr.)	170°

* Purchased specimen.
[a] Equivalent to 17.73 per cent. of narceine hydrochloride ($C_{23}H_{27}O_9N.HCl.3H_2O$).
[b] Equivalent to 14.43 per cent. of narceine hydrochloride.

Because of the similarity between the solubilities of narceine and narceine hydrochloride it is very difficult to separate the two substances by means of solvents. Consequently commercial narceine is usually contaminated with this impurity. E. Merck [14] is of the opinion that a preparation which is free from meconin and which does not melt below 165° C. is of sufficient purity for most purposes.

Narceine is distinguished from codeine by its weak basic properties, its scant solubility in most of the ordinary organic solvents, by the formation of a blue instead of a reddish-brown precipitate with very dilute iodine solution; by the production of a brown instead of a violet color with Marquis' reagent, and a light brown instead of a green color with Lafon's reagent; from morphine by its weak basic properties, its failure to reduce iodic acid, its comparatively ready solubility in hot water and in ammonia water, by the formation of a blue instead of a reddish-brown precipitate with very dilute

[14] *Chem. Ztg.*, 13, 525 (1889).

iodine solution, by the production of a brown instead of a purple color with Marquis' reagent, a brownish-green instead of a purple color with Fröhde's reagent, and a light brown instead of a blue color with Lafon's reagent; from narcotine by its scant solubility in most of the ordinary organic solvents, its comparatively easy solubility in hot water or in ammonia water, by the formation of a blue instead of a reddish-brown precipitate with very dilute iodine solution, by the production of a brown instead of a green color with Lafon's reagent, and a brown instead of an orange color with Mandelin's reagent; from papaverine by its scant solubility in most of the organic solvents, its comparatively easy solubility in hot water or in ammonia water, by the formation of a blue instead of a reddish-brown precipitate with very dilute iodine solution, by the production of a brown instead of a deep rose color with Marquis' reagent, a brown instead of a greenish-blue color with potassium ferricyanide and Marquis' reagent, and a light brown instead of a green color with Lafon's reagent; from thebaine by its weak basic properties, its comparatively easy solubility in hot water or in ammonia water, its scant solubility in most of the ordinary organic solvents, by the formation of a blue instead of a reddish-brown precipitate with very dilute iodine solution, the formation of an orange-red instead of a reddish-brown coloration with chlorine water and ammonia water, and by the production of a yellow instead of a deep blood-red color with sulphuric acid.

Narcotine.

The tests to which the specimens of narcotine were subjected included limit tests for chloride, meconates, sulphates, codeine, morphine, papaverine, and thebaine, as well as a determination of the melting-point of the dried alkaloid.

The results obtained are given herewith.

Two specimens of narcotine were received. One (Merck) was a white crystalline powder, the other (M. C. W.) in the form of colorless prisms. The latter was stated not to be a market preparation, but to have been prepared by the manufacturer for research purposes. Portions of each specimen dissolved in diluted hydrochloric acid without residue. Each was free from chloride, sulphates, meconates, codeine, morphine, papaverine, and thebaine.

Narcotine is distinguished from codeine by its weak basic properties, its scant solubility in water or in ammonia water, by the production of a pale, evanescent violet instead of a deep, bluish-violet color with Marquis' reagent, and an orange-red instead of a pale green color with Mandelin's reagent; from morphine by its weak basic properties, its ready solubility in ether, chloroform, and benzene, its failure to reduce iodic acid, by the production of a yellowish-green instead of a purple color with Fröhde's reagent, and a pale, evanescent violet instead of a deep purple color with Marquis' reagent; from narceine by the formation of a brownish-red instead of a blue precipitate with very dilute

iodine solution; from papaverine by the production of a pale, evanescent violet instead of a deep rose color with Marquis' reagent, and a dirty, evanescent violet instead of a greenish-blue color with potassium ferricyanide and Marquis' reagent; and from thebaine by its weak basic properties and by the production of a pale, evanescent violet instead of a deep blood-red color with Marquis' reagent.

The Merck specimen melted at 175.3° C. (corr.).

The M. C. W. specimen melted at 174.° C. (corr.).

A purchased specimen of narcotine (Merck) melted at 174.6° (corr.).

Comparison of the other findings with those obtained from the purchased specimen of narcotine showed no material differences.

The results, therefore, indicate that the specimens are of good quality.

Narcotine Hydrochloride.

The tests to which the specimen of narcotine hydrochloride was subjected were essentially the same as for narcotine. Narcotine alkaloid was determined by dissolving the salt water, making the solution alkaline, shaking with chloroform, evaporating the chloroform extractions, drying the residue, and weighing. In addition to the other tests, chloride was determined in the solution from which the alkaloid had been removed by acidifying with nitric acid, precipitating with silver nitrate, drying the precipitate, and weighing the silver chloride.

The results obtained in the examination are given below.

White powder; soluble in water without residue. The specimen was free from sulphates, meconates, codeine, morphine, and papaverine.

Comparison of the findings with those obtained from a purchased specimen of narcotine hydrochloride showed that there were no appreciable differences.

The findings for the two specimens are given in Table IV.

Table IV.

Composition of Two Specimens of Commercial Narcotine Hydrochloride

	Merck	Merck*	Theory
Hydrochloric acid (HCl).....	8.41	7.88	8.11
Anhydrous alkaloid.....	89.47	91.1	91.89
Melting-point of isolated alkaloid...	174° (corr.)	174° (corr.)	174°–176°

* Purchased specimen.

The ready solubility of codeine in water and in ammonia water suggested that this property might be utilized for the detection of small quantities of codeine in presence of relatively large quantities of those alkaloids which are very insoluble in water, such as narcotine and papaverine.[15] Accordingly several mixtures in known proportions of codeine and the named alkaloids or of their salts were prepared. In each case the mixture was dissolved in 50 Cc. of water, containing a few drops of hydrochloric acid, a very slight excess of diluted ammonia water added with stirring, the mixture set aside for about eighteen hours, the precipitate collected in a weighed Gooch crucible, dried and weighed. The filtrate was then shaken with successive portions of ether until extraction was complete, the ether extracts united, washed with water, evaporated, the residue dried and weighed. Controls were carried out with the respective alkaloids or their salts without admixture with codeine. The alkaloidal residues from the controls amounted to but few milligrammes in each case. If this quantity were subtracted from the residue obtained from the extraction of the codeine mixture it was found that the remainder was a close approximation to the quantity of codeine taken.

Results.—From 0.2596 Gm. of narcotine, a precipitate weighing 0.2569 Gm. was obtained, equivalent to 98.96 per cent. of the amount of narcotine taken, and an anhydrous ether extract residue weighing 0.0038 Gm. was obtained equivalent to 1.46 per cent. of the quantity taken. The ether extract residue gave tests for narcotine, but did not respond to tests for codeine. From 0.2515 Gm. of narcotine to which 0.0267 Gm. of anhydrous codeine had been added, a precipitate weighing 0.2494 Gm. was obtained, equivalent to 98.37 per cent. of the amount of narcotine taken, and an anhydrous ether extract residue weighing 0.0270 Gm. was obtained, equivalent to 101.1 per cent. of the amount of codeine taken. From 0.1644 Gm. of narcotine a precipitate weighing 0.1622 Gm. was obtained, equivalent to 98.66 per cent. of the amount of narcotine taken. The filtrate gave an ether extract residue weighing 0.0017 Gm., or 1.03 per cent. of the quantity of narcotine taken. This gave tests for narcotine, but did not respond to tests for codeine. From 0.2315 Gm. of narcotine a precipitate weighing 0.2305 Gm. was obtained, equivalent to 98.71 per cent. of the amount of narcotine taken. The ether extract

[15] This method has long been used for approximately separating morphine from codeine.

weighed 0.0020 Gm., equivalent to 0.86 per cent. of the quantity of narcotine taken. The residue responded to tests for narcotine, but not to tests for codeine. From 0.2286 Gm. of narcotine to which 0.0233 Gm. of anhydrous codeine had been added, a precipitate weighing 0.2272 Gm. was obtained, equivalent to 99.39 per cent. of the quantity of narcotine taken; and an ether extract weighing 0.0232 Gm. was obtained, equivalent to 99.57 per cent. of the quantity of codeine taken.

From these tests it can be seen that the presence of small quantities of codeine in narcotine can be detected readily by the method, and, further, can even be determined with a moderate degree of accuracy.

Papaverine Hydrochloride.

The tests to which the specimens of papaverine hydrochloride were subjected included identification, determinations of the alkaloid and chloride, melting-point of the isolated alkaloid, and qualitative tests for sulphates, meconates, codeine, cryptopine, narcotine, and morphine.

In addition to the specimen of papaverine hydrochloride sent by Dr. Macht and the one purchased, a specimen of the salt was included in the examination which had been submitted by its manufacturer to the Council on Pharmacy and Chemistry for inclusion with New and Non-Official Remedies. The results obtained in the examination of the several specimens are given below.

Each of the specimens was a white, crystalline, odorless powder, which dissolved in water without leaving any residue to form a clear solution having an acid reaction. Each of the specimens was free from sulphates, meconates, codeine, and morphine, but two of them appeared to contain traces of cryptopine. The findings for the three specimens are given in Table V.

Table V.

Composition of Three Specimens of Papaverine Hydrochloride.

	Roche	Roche *	Merck †	Theory
Moisture	....	0.14	0.12	0
Alkaloid	90.18	90.41	90.38	90.30
Hydrochloric acid (HCl)	9.75	9.73	9.84	9.70
Melting-point of isolated alkaloid	146.8° (corr.)	146.7° (corr.)	147.3° (corr.)	147°

* Purchased specimen.
† Specimen submitted to the Council on Pharmacy and Chemistry.

In 1910 Pictet and Kraemers [16] pointed out that most of the color reactions for papaverine described in the literature were not due to that alkaloid, but to cryptopine, which at that time was present as an impurity in commercial papaverine to the extent of as high as 4 per cent. These authors obtained pure papaverine in the form of its acid oxalate by precipitating with oxalic acid in the presence of alcohol. The cryptopine was then recovered from the filtrate by making alkaline and shaking with appropriate solvents. The papaverine was recovered from the oxalate by dissolving in hot water, making alkaline and shaking with appropriate solvents.

Papaverine is distinguished from codeine by its weak basic properties, its scant solubility in water or in ammonia water, by the production of a deep rose instead of a violet color with Marquis' reagent and a greenish-blue instead of a violet color with potassium ferricyanide and Marquis' reagent; from morphine by its weak basic properties, its ready solubility in most of the ordinary organic solvents, its failure to reduce iodic acid, by the production of a deep rose instead of a purple color with Marquis' reagent, and a greenish-blue in stead of a purple color with potassium ferricyanide and Marquis' reagent; from narceine by its ready solubility in most of the ordinary organic solvents, by its scant solubility in hot water or in ammonia water, by the formation of a reddish-brown instead of a blue precipitate with very dilute iodine solution, by the production of a deep rose instead of a brown color with Marquis' reagent, and a greenish-blue instead of a brown color with potassium ferricyanide and Marquis' reagent; from narcotine by the production of a deep rose instead of a fugitive violet color with Marquis' reagent, and a greenish-blue instead of a dirty, evanescent violet color with potassium ferricyanide and Marquis' reagent; and from thebaine by its weak basic properties, by the production of a colorless instead of a deep blood-red solution with sulphuric acid, a deep rose instead of a deep blood-red color with Marquis' reagent, and a greenish-blue instead of a deep blood-red color with potassium ferricyanide and Marquis' reagent.

In testing the specimens of papaverine hydrochloride for traces of cryptopine salts it was found desirable to remove the papaverine as completely as possible, so as to leave the cryptopine in as high concentration as possible. Precipitation as acid oxalate was tried, but was found not to be as satisfactory as precipitation by potassium ferricyanide to form the acid papaverine ferricyanide. This was collected in a weighed Gooch crucible, washed with a little water, dried at 100° C., and weighed. The filtrate was made alkaline with ammonia water, the mixture shaken with chloroform, the solvent

[16] *Ber.*, 43, 1329 (1910).

washed with water, evaporated, the residue dried at 100° C., and weighed. If the quantities of papaverine hydrochloride taken for the test lay between 0.2 and 0.3 Gm. the residues obtained by this method usually amounted to less than 2 per cent. The residue in all cases consisted principally of papaverine which had escaped precipitation. From the violet color produced by solution in sulphuric acid it was concluded that traces of cryptopine were present in two of the residues. Codeine was not present in any. The following results were obtained:

From 0.2842 Gm. of papaverine hydrochloride, equivalent to 0.2566 Gm. of papaverine, 0.3103 Gm. of papaverine ferricyanide was obtained, equivalent to 0.2535 Gm. of papaverine, or 98.77 per cent. of the theoretical amount. From the filtrate a residue weighing 0.0032 Gm. was obtained, equivalent to 1.25 per cent. of the alkaloid taken. From 0.3282 Gm. of papaverine hydrochloride, equivalent to 0.2964 Gm. of papaverine, 0.3521 Gm. of papaverine ferricyanide was obtained, equivalent to 0.2907 Gm. of papaverine, or 98.07 per cent of the theoretical amount. From the filtrate a residue weighing 0.0065 Gm. was obtained, equivalent to 1.98 per cent. of the alkaloid taken.

Tests for codeine were made by the water solubility method already described under narcotine hydrochloride. The following results were obtained:

From 0.5028 Gm. of papaverine hydrochloride, equivalent to 0.4540 Gm. of papaverine, a precipitate weighing 0.4560 Gm. was obtained, equivalent to 100.44 per cent. of the theoretical amount of papaverine taken. The filtrate gave an anhydrous ether extract residue weighing 0.0032 Gm., or 0.71 per cent. of the theoretical quantity of papaverine taken. This residue gave tests for papaverine, but no satisfactory tests for codeine or cryptopine could be obtained. From 0.2070 Gm. of papaverine hydrochloride, equivalent to 0.1869 Gm. of papaverine, a precipitate weighing 0.1857 Gm. was obtained, equivalent to 99.04 per cent. of the theoretical amount of papaverine taken. From the filtrate an anhydrous ether-extract residue was obtained weighing 0.0014 Gm., equivalent to 0.75 per cent. of the theoretical amount of papaverine taken. From 0.2255 Gm. of papaverine hydrochloride, equivalent to 0.2036 Gm. of papaverine, to which 0.0121 Gm. of anhydrous codeine had been added, a precipitate weighing 0.2010 Gm. was obtained, equivalent to 98.72 per cent. of the theoretical amount of papaverine taken. From the

filtrate an anhydrous ether-extract residue weighing 0.0142 Gm. was obtained, equivalent to 117.3 per cent. of the amount of codeine taken. This residue gave tests for papaverine and for codeine.

It is evident, therefore, that the method can be used for the detection of small quantities of codeine in much larger quantities of papaverine, and can even be employed to approximately separate the two alkaloids from each other in such mixture.

Thebaine Hydrochloride.

The tests to which the specimens of thebaine hydrochloride were subjected included determinations of the water of hydration (loss at 100° C. in a partial vacuum), of the alkaloid, and of the chloride; the application of limit tests for meconates, sulphates, papaverine, and morphine.

The results obtained in the examination are given below.

But one specimen of thebaine hydrochloride was examined: faintly yellowish, odorless, rhombic prisms, which yielded a white powder on crushing. The salt dissolved in water, forming a colorless, neutral solution. Meconate, sulphates, papaverine, and morphine were absent. The analytical findings are given in Table VI.

Table VI.

Composition of a Specimen of Commercial Thebaine Hydrochloride.

	Merck	Theory
Water (loss at 100° in vacuum)	4.22	4.93
Anhydrous alkaloid	85.20	85.10
Hydrochloric acid (HCl)	9.98	9.97
Melting-point of isolated alkaloid	193.2° (corr.)	193°

Because of the more ready solubility of thebaine in water, as compared with narcotine and papaverine, it was found that the water-solubility test could not be used to separate thebaine from codeine. The method was tried as described for narcotine, but the results were not encouraging, as is shown by the findings given below.

From 0.2329 Gm. of thebaine hydrochloride, equivalent to 0.1982 Gm. of anhydrous alkaloid, a precipitate weighing 0.1497 Gm. was obtained, equivalent to 75.43 per cent. of the quantity of thebaine taken. From the filtrate an anhydrous ether-extract residue weighing 0.0482 Gm. was obtained, equivalent to 24.32 per cent. of the

amount of thebaine taken. From 0.2033 Gm. of thebaine hydrochloride, equivalent to 0.1730 Gm. of anhydrous thebaine, to which 0.0229 Gm. of anhydrous codeine had been added, a precipitate weighing 0.1225 Gm. was obtained, equivalent to 70.80 per cent. of the amount of thebaine taken. From the filtrate an anhydrous ether-extract residue weighing 0.0713 Gm. was obtained, equivalent to 311.3 per cent. of the quantity of codeine taken.

Thebaine is distinguished from codeine by its scant solubility in water or in ammonia water, and by the production of a deep blood-red instead of a violet color with Marquis' reagent; from morphine by its ready solubility in most of the ordinary organic solvents, its failure to reduce iodic acid, by the production of a yellow instead of an orange-red color with nitric acid, and a deep blood-red instead of a purple color with Marquis' reagent; from narceine by its scant solubility in water or in ammonia water, its ready solubility in most of the ordinary organic solvents, by the production of a brownish-red instead of a blue precipitate with very dilute iodine solution, a reddish-brown instead of an orange-red color with chlorine water and ammonia water, and a brown instead of a deep blood-red color with Marquis' reagent; from narcotine by its strong basic properties, and by the production of a deep blood-red instead of a fugitive violet color with Marquis' reagent; and from papaverine by its strong basic properties, by the production of a deep blood-red instead of a deep rose color with Marquis' reagent, and a deep blood-red instead of a greenish-blue color with potassium ferricyanide and Marquis' reagent.

The analytical findings indicate that the quality of some of the specimens examined is fair and of some excellent, while none of the specimens should be classed as of poor quality. The presence of less than 1 per cent. of codeine sulphate in morphine sulphate probably cannot modify the pharmacologic effect of the morphine to any marked extent. Probably the same may be said of the presence of 15 per cent. of narceine hydrochloride in narceine, as in this instance the proportion of hydrochloric acid amounts to only about 1 per cent. of the entire substance.

Based for the most part upon information compiled from the literature, but supplemented to some extent by deductions from the results obtained in the examination of the several previously-named specimens, tentative monographs for the several substances examined (except for codeine phosphate and morphine sulphate, which are described in the U. S. Pharmacopœia) have been prepared. While the lists of tests in these monographs are in no sense complete, it is believed that they are adequate both for the identification of the several substances and to insure products of a sufficient degree of purity

for medicinal purposes. Although the tests are tentative in nature, it was thought worth while to publish them in the hope that they might prove useful to analysts, and also, possibly, to manufacturers who may wish to prepare standards for the substances in question.

In preparing these tentative monographs an endeavor was made to select and arrange the qualitative tests so that they should be as distinctive as possible for the particular alkaloid sought. For example, narcotine, papaverine, and thebaine are each precipitated by potassium ferricyanide solution, but at widely different dilutions. According to Plugge,[17] narcotine and thebaine are not precipitated by this reagent from dilutions above 0.25 per cent., while papaverine may still be precipitated from dilutions of 0.025 per cent. if the solution be allowed to stand. Narceine may be precipitated from its salts by potassium ferricyanide solution as free alkaloid. Morphine and codeine are not precipitated as ferricyanides even from highly-concentrated solutions. Consequently, by taking care that the alkaloidal solution be less than 0.25 per cent. in strength, papaverine alone of the six more important opium alkaloids is precipitated by potassium ferricyanide as the alkaloidal ferricyanide. Again, narcotine and papaverine are the only alkaloids of the group which are precipitated in the free state by sodium acetate solution.

Monograph I.

Narceine ($C_{23}H_{27}O_8N \cdot 3H_2O$).

Narceine occurs in fine, white, silky needles or in white prisms which may be partially effloresced to a grayish-white powder; odorless and having a slightly bitter taste, with a styptic after-taste.

Slightly soluble in water; readily soluble in hot water; slightly soluble in alcohol; readily soluble in hot alcohol; insoluble in ether; insoluble in chloroform, petroleum ether, or benzene; soluble in a warm mixture of equal parts of chloroform and isobutyl alcohol; somewhat soluble in ammonia water and in diluted potassium hydroxide solution.

At 100° C. narceine loses its water of hydration (10.8 per cent.). If exposed to the air the anhydrous alkaloid absorbs water equivalent to one molecule of water of hydration. The water of hydration in commercial narceine is variable, the quantity depending somewhat on the method of crystallization.

[17] *Arch. Pharm.*, **225**, 809 *et seq.* (1887).

The melting-point of narceine is variable, depending upon its content of water of hydration. Fully-hydrated narceine melts at 170°; the anhydrous base melts at 163° to 165°; admixture with narceine hydrochloride lowers the melting-point.

A solution of narceine in hot water is neutral and is optically inactive.

If about 0.01 Gm. of narceine be dissolved in 10 Cc. of water containing a few drops of hydrochloric acid, a few drops of a very weak iodine solution (about 1 in 1000) added, and the mixture shaken for several minutes, a dark blue precipitate should be produced (distinction from *other opium alkaloids*).

If about 0.01 Gm. of narceine be dissolved in 10 Cc. of warm water containing a few drops of hydrochloric acid, the solution cooled, and a few drops of potassium-zinc iodide solution added, a precipitate of white, hair-like crystals should slowly be formed; the crystals become blue on standing (distinction from *other opium alkaloids*).

If about 0.01 Gm. of narceine be dissolved in 5 Cc. of water containing a few drops of hydrochloride acid and 1 Cc. of chlorine water added, followed by an excess of ammonia water, an orange-red coloration should be produced (distinction from *thebaine,* which gives a reddish-brown color).

If about 0.001 Gm. of narceine be dissolved in 0.1 Cc. of nitric acid a rapidly fading yellow color should be produced.

If about 0.001 Gm. of narceine be dissolved in 0.1 Cc. of sulphuric acid a yellowish-brown coloration should be produced; this slowly changes to cherry red on standing; more quickly on warming.

If about 0.001 Gm. of narceine be dissolved in 0.2 Cc. of sulphuric acid in which about 0.001 Gm. of gallic acid has previously been dissolved, a brownish-yellow solution should be produced; on cautiously heating the solution it successively becomes green, bluish-violet, and finally dark violet.

If about 0.01 Gm. of narceine be evaporated with diluted sulphuric acid on a water-bath, a violet coloration should be produced; this changes to cherry red on further heating; when cold, this yields, on the addition of a trace of nitric acid or potassium nitrate, streaks of a blue-violet color.

If about 0.001 Gm. of narceine be dissolved in 0.1 Cc. of sulphuric acid which contains a trace of iodic acid, a chocolate-brown color should be produced.

If about 0.01 Gm. of narcotine be dissoved in 1 Cc. of water

containing a few drops of hydrochloric acid and a few drops of ferric chloride solution added, a red coloration should not be produced (absence of *meconic acid or meconates*); the further addition of a few drops of potassium ferricyanide solution should not immediately produce a blue color (absence of *morphine*).

If 0.1 Gm. of narceine be dissolved in 10 Cc. of water containing a few drops of hydrochloric acid, a few drops of a saturated aqueous solution of iodic acid added, and the mixture shaken with 2 Cc. of chloroform, the chloroform layer should not be colored violet (absence of *morphine*).

If 0.1 Gm. of narceine be dissolved in 10 Cc. of a 5 per cent. potassium hydroxide solution, the solution shaken with several small successive portions of ether, the ether solutions combined, washed with water, and evaporated, the residue, if any, should not respond to tests for *codeine, narcotine* or *papaverine.*

If 0.01 Gm. of narceine be dissolved in 10 Cc. of water containing a few drops of hydrochloric acid the solution should not at once become turbid on the addition of barium chloride solution (limit of *sulphates*).

If from 0.2 Gm. to 0.3 Gm. of narceine be weighed and the alkaloid burned, the ash should not amount to more than 0.1 per cent. of the weight taken.

If from 0.2 to 0.3 Gm. of narceine be weighed, dissolved in about 25 Cc. of warm water containing a few drops of nitric acid, the solution heated, a slight excess of silver nitrate solution added, the precipitate of silver chloride, if any, collected, dried, and weighed in the usual way, the silver chloride found should not correspond to more than 10 per cent. of narceine hydrochloride in the material taken.

Monograph II.

Narcotine ($C_{22}H_{23}O_7N$).

Narcotine occurs in colorless, shining, rhombic prisms, in long needles or in fine, white crystalline powder; odorless and tasteless; permanent in the air.

Narcotine is insoluble in water; soluble in hot alcohol, ether, chloroform, ethyl acetate, and benzene; insoluble in cold but soluble in boiling alkaline solutions.

Narcotine melts at 174 to 176°. At higher temperatures narcotine is decomposed with evolution of ammonia.

Narcotine is lævorotatory, the specific rotatory power being $-207.35°$ in chloroform.

If about 0.01 Gm. of narcotine be dissolved in 10 Cc. of water containing a few drops of diluted hydrochloric acid and a few drops of potassium sulphocyanate solution added, a white precipitate should be produced (distinction from *many other opium alkaloids*).

If about 0.01 Gm. of narcotine be dissolved in 1 Cc. of water containing a few drops of diluted hydrochloric acid, a few drops of a 10 per cent. solution of sodium salicylate added, and the mixture shaken, a white precipitate should be produced which soon collects in resin-like masses which later become crystalline (distinction from *many other opium alkaloids*).

If about 0.01 Gm. of narcotine be dissolved in 10 Cc. of warm water containing a few drops of diluted hydrochloric acid, the solution cooled, and a few drops of a 25 per cent solution of sodium acetate added, a white precipitate should be produced at once (distinction from *many other opium alkaloids*).

If about 0.01 Gm. of narcotine be dissolved in 10 Cc. of water containing a few drops of diluted hydrochloric acid and a few drops of bromine water added, a yellow precipitate should be produced which dissolves on boiling; if more of the bromine solution be added in small portions and the boiling repeated after each addition, a fine rose color should be produced (distinction from *other opium alkaloids*).

If about 0.001 Gm. of narcotine be dissolved in 0.1 Cc. of nitric acid a yellow color should be produced.

If about 0.001 Gm. of narcotine be dissolved in 0.1 Cc. of sulphuric acid, a green-yellow color should be produced; on warming the color becomes red, and on boiling, violet.

If about 0.001 Gm. of narcotine be dissolved in 0.1 Cc. of sulphuric acid which contains a trace of nitric acid a brownish-red color should be produced; this soon changes to a blood-red color which is very persistent.

If about 0.001 Gm. of narcotine be dissolved in 0.2 Cc. of sulphuric acid in which about 0.001 Gm. of gallic acid has previously been dissolved and the mixture heated cautiously, a green color should be produced which changes to deep blue on further heating.

If about 0.001 Gm. of narcotine be dissolved in about 0.1 Cc. of sulphuric acid which contains a trace of selenious acid, a green color should be produced which changes to greenish blue, then to violet blue, then to brown, and finally to cherry red.

If about 0.001 Gm. of narcotine be dissolved in 0.1 Cc. of sulphuric acid which contains a trace of iodic acid, a violet color should be produced, which immediately becomes brown and eventually cherry red (distinction from *morphine* which yields a violet color soon becoming brown, and from *codeine* which yields a moss-green color changing to brown).

If 0.01 Gm. of narcotine be dissolved in 10 Cc. of diluted hydrochloric acid and a few drops of ferric chloride solution added, a red coloration should not be produced (absence of *meconic acid or meconates*); the further addition of a few drops of potassium ferricyanide solution should not immediately produce a blue color (absence of *morphine*).

If 0.1 Gm. of narcotine be dissolved in 10 Cc. of water containing a few drops of diluted hydrochloric acid, a few drops of a saturated aqueous solution of iodic acid added, and the solution shaken with 2 Cc. of chloroform, the chloroform layer should not be colored violet (absence of *morphine*).

If 0.1 Gm. of narcotine be shaken with 10 Cc. of a 5 per cent. solution of potassium hydroxide, the mixture allowed to stand for an hour, filtered, and 2 Cc. of ammonium chloride solution added to the filtrate, no crystals should separate within twenty-four hours (absence of *morphine*).

If from 0.2 to 0.3 Gm. of narcotine be weighed, dissolved in 50 Cc. of hot water containing a few drops of hydrochloric acid, a slight excess of very dilute ammonia water added with stirring, the mixture allowed to stand over night, filtered, the filtrate shaken with several successive portions of ether, the ether solutions combined, washed with water, and evaporated, the residue, if any, should not respond to tests for *codeine*.

If 0.1 Gm. of narcotine be dissolved in 5 Cc. of water containing a few drops of diluted hydrochloric acid, the solution evaporated to dryness, the residue dissolved in 40Cc. of water, a few drops of freshly-prepared potassium ferricyanide solution added, and the mixture shaken, a yellow precipitate should not form within ten minutes (limit of *papaverine*).

If 0.1 Gm. of narcotine be dissolved in 10 Cc. of water containing a few drops of nitric acid, portions of the solution should not at once become turbid on the addition of barium chloride solution (limit of *sulphates*), or of silver nitrate solution (limit of *chlorides*).

If from 0.2 Gm. to 0.3 Gm. of narcotine be weighed and the

alkaloid burned, the ash should not exceed 0.1 per cent. of the weight taken.

If from 0.2 to 0.3 Gm. of narcotine be weighed, dissolved in 10 Cc. of water containing a few drops of sulphuric acid, a slight excess of ammonia water added, the mixture shaken with three successive portions of 15 Cc. each of chloroform, or a sufficient quantity to complete the extraction, the combined chloroform solutions evaporated to dryness, the residue dried to constant weight at 100° C. and weighed, the weight should indicate not less than 99.5 per cent. of narcotine.

Monograph III.

Narcotine Hydrochloride ($C_{22}H_{23}O_7N$. HCl).

The hydrochloride of the alkaloid, narcotine, containing not less than 91.5 per cent. of narcotine.

Narcotine hydrochloride occurs in a fine, white, crystalline powder; odorless; taste bitter; permanent in the air.

Narcotine hydrochloride is soluble in water; soluble in alcohol; soluble in chloroform; insoluble in ether; insoluble in cold but soluble in boiling alkaline solutions.

An aqueous solution of narcotine hydrochloride is neutral to litmus paper and is dextrorotatory, the specific rotatory power being 43.18° at 15° C.

If added to an aqueous solution of narcotine hydrochloride, silver nitrate solution should produce a white precipitate which is insoluble in nitric acid.

If from 0.2 to 0.3 Gm. of narcotine hydrochloride be weighed, dissolved in 10 Cc. of water, a slight excess of ammonia water added, the mixture shaken with three successive portions of 15 Cc. each of chloroform, or a sufficient quantity to complete the extraction, the combined chloroform solutions washed with water, evaporated to dryness, the residue dried to constant weight at 100° C., and weighed, the weight should indicate not less than 91.5 per cent. of narcotine. The alkaloid obtained by this process should conform to the tests for identity and purity described under narcotine.

Monograph IV.

Papaverine Hydrochloride ($C_{20}H_{21}O_4N$. HCl).

The hydrochloride of the alkaloid, papaverine, containing not less than 88 per cent. of papaverine.

Papaverine hydrochloride occurs in a fine, white, crystalline

powder or in small monoclinic plates, or in prisms; odorless and having a bitter taste; permanent in the air.

Papaverine hydrochloride is sparingly soluble in water; soluble in alcohol; very soluble in chloroform; insoluble in ether.

An aqueous solution of papaverine hydrochloride has an acid reaction toward litmus paper and is optically inactive.

If added to an aqueous solution of papaverine hydrochloride, silver nitrate solution should produce a white, curdy precipitate which is insoluble in nitric acid.

If about 0.01 Gm. of papaverine hydrochloride be dissolved in 5 Cc. of water and a few drops of cadmium-potassium iodide solution added, a dense, white precipitate should be produced.

If about 0.01 Gm. of papaverine hydrochloride be dissolved in 1 Cc. of hot alcohol, 0.5 Cc. of tincture of iodine added, the mixture shaken and allowed to stand, reddish-brown, crystalline needles of papaverine periodide should gradually appear.

If about 0.01 Gm. of papaverine hydrochloride be dissolved in 10 Cc. of water and a few drops of potassium ferricyanide solution added, a lemon-yellow precipitate of papaverine ferricyanide should form at once (distinction from the *salts* of *other opium alkaloids*).

If about 0.01 Gm. of papaverine hydrochloride be dissolved in 10 Cc. of water and a few drops of a 25 per cent. solution of sodium acetate added, a white precipitate should be produced at once (distinction from the *salts* of *many other opium alkaloids*).

If about 0.1 Gm. of papaverine hydrochloride be dissolved in a hot solution of 0.04 Gm. of oxalic acid in 5 Cc. of water, the solution cooled and agitated for some time, small, short, opaque, prisms of papaverine acid oxalate should form after standing (distinction from the *salts* of *other opium alkaloids*).

If about 0.01 Gm. of papaverine hydrochloride be dissolved in 5 Cc. of water and a few drops of platinum chloride solution added, a pale yellow, amorphous precipitate should immediately be produced. This soon crystallizes into lance-shaped prisms, many of which are arranged in rosettes and tree-like forms (distinction from the *salts* of *other opium alkaloids*).

If about 0.01 Gm. of papaverine hydrochloride be dissolved in 0.1 Cc. of sulphuric acid in which a trace of iodic acid has previously been dissolved, a purple color should be produced which almost immediately becomes streaked with brown.

If about 0.001 Gm. of papaverine hydrochloride be dissolved in 0.1 Cc. of sulphuric acid containing in each Cc. one drop of formaldehyde solution, a colorless solution, or at most a faintly yellowish-green color, should be produced; this gradually changes to a deep rose, which lasts for some time, the mixture finally becoming brown (distinction from the *salts of morphine and its esters,* which immediately give purple or violet colors).

If about 0.001 Gm. of papaverine hydrochloride be intimately mixed with about 0.001 Gm. of finely-powdered potassium ferricyanide and the mixture dissolved in 0.2 Cc. of sulphuric acid containing in each Cc. one drop of formaldehyde solution, a light blue or greenish-blue color should be produced at once; this gradually changes successively to deep blue, violet blue (or bluish violet), emerald green and finally pale brownish yellow (distinction from *other opium alkaloids*). Certain other oxidizing agents, such as ammonium vanadate, cerium oxide, potassium permanganate, selenious acid, and sodium ortho-arsenate, also give the reaction with slight individual variations in the shades of color produced.

If 0.01 Gm. of papaverine hydrochloride be dissolved in 0.1 Cc. of sulphuric acid, the solution should not be colored more than very faintly pinkish or brownish (limit of the *salts of cryptopine, thebaine, etc., or of other organic impurities*).

If 0.1 Gm. of papaverine hydrochloride be dissolved in 10 Cc. of water and a few drops of ferric chloride solution added, a red coloration should not be produced (absence of *meconic acid or meconates*).

If 0.1 Gm. of papaverine hydrochloride be shaken with 10 Cc. of a 5 per cent. solution of potassium hydroxide, the mixture allowed to stand for an hour, filtered, and 2 Cc. of ammonium chloride solution added to the filtrate, no crystals should separate within twenty-four hours (absence of *morphine salts*).

If 0.1 Gm. of papaverine hydrochloride be dissolved in 10 Cc. of water, a few drops of a saturated aqueous solution of iodic acid added, and the mixture shaken with 2 Cc. of chloroform, the chloroform layer should not be colored violet (absence of *morphine salts*).

If from 0.2 to 0.3 Gm. of papaverine hydrochloride be weighed, dissolved in 50 Cc. of hot water, a slight excess of very dilute ammonia water added with stirring, the mixture allowed to stand over night, filtered, the filtrate shaken with several successive portions of ether, the ether solutions combined, washed with water, and evaporated, the residue if any, should not respond to tests for *codeine.*

If 0.1 Gm. of papaverine hydrochloride be dissolved in 10 Cc. of water and a few drops of hydrochloric acid added, the solution should not at once become turbid on the addition of a few drops of barium chloride solution (limit of *sulphates*).

If from 0.2 to 0.3 Gm. of papaverine hydrochloride be weighed and the salt burned, the ash should not exceed 0.1 per cent. of the weight taken.

If from 0.2 to 0.3 Gm. of papaverine hydrochloride be weighed, dissolved in 20 Cc. of warm water, the solution cooled, a slight excess of ammonia water added, and the mixture shaken with three successive portions of 25 Cc. each of ether, or a sufficient quantity to complete the extraction, the ether solutions combined, washed with water, evaporated to dryness, the residue dried to constant weight at 100° C. and weighed, the weight should indicate not less than 88 per cent. of papaverine. The alkaloid obtained by this process should melt between 146.5° and 147.5° C.

If from 0.2 to 0.3 Gm. of papaverine hydrochloride be weighed, dissolved in 20 Cc. of warm water, the solution cooled, a few drops of diluted hydrochloric acid added, 1 Cc. of freshly-prepared potassium ferricyanide solution added, the mixture agitated, allowed to stand over night, filtered, the filtrate made alkaline with ammonia water, shaken with several successive portions of ether, the ether solutions combined wasted with water, evaporated, the residue dried at 100° C. and weighed, the weight should not amount to more than 2 per cent. of the weight taken (limit of the *salts of foreign opium alkaloids*).

Monograph V.

Thebaine Hydrochloride ($C_{19}H_{21}O_3N \cdot HCl \cdot H_2O$).

The hydrochloride of the alkaloid, thebaine, containing not less than 84.5 per cent. of thebaine.

Thebaine hydrochloride occurs in colorless, or very faintly yellowish, rhombic prisms; odorless; taste acrid and styptic; permanent in the air.

Thebaine hydrochloride is soluble in water; soluble in alcohol; very soluble in chloroform; insoluble in ether.

At 110° C. thebaine hydrochloride loses its water of hydration (4.9 per cent.) with slight decomposition. At 100° C. in a vacuum the salt becomes anhydrous without decomposition. If exposed to the air the anhydrous salt absorbs water equivalent to one molecule of water of hydration.

An aqueous solution of thebaine hydrochloride is neutral to lit-

mus paper and is lævorotatory, the specific rotatory power being −168.32°.

If added to an aqueous solution of thebaine hydrochloride, silver nitrate should produce a white, curdy precipitate which is insoluble in nitric acid.

If about 0.01 Gm. of thebaine hydrochloride be dissolved in 5 Cc. of water and a few drops of a 10 per cent. solution of sodium salicylate added, a white, voluminous precipitate of thebaine salicylate should be produced (distinction from the *salts of many other opium alkaloids*).

If about 0.01 Gm. of thebaine hydrochloride be dissolved in 5 Cc. of water and 1 Cc. of chlorine water added, followed by an excess of ammonia water, a reddish-brown color should be produced (distinction from *narceine salts,* which give an orange-red color).

If about 0.001 Gm. of thebaine hydrochloride be dissolved in 0.1 Cc. of nitric acid, a yellow color should be produced.

If about 0.001 Gm. of thebaine hydrochloride be dissolved in 0.1 Cc. of hydrochloric acid, an orange-yellow color should be produced.

If about 0.001 Gm. of thebaine hydrochloride be dissolved in 0.1 Cc. of sulphuric acid, a blood-red color should be produced; on warming this changes to orange yellow and eventually to olive green (distinction from the *salts of other opium alkaloids*).

If 0.1 Gm. of thebaine hydrochloride be dissolved in 10 Cc. of water and a few drops of ferric chloride solution added, a red coloration should not be produced (absence of *meconic acid or meconates*); the further addition of a few drops of potassium ferricyanide solution should not immediately produce a blue color (absence of *morphine salts*).

If 0.1 Gm. of thebaine hydrochloride be dissolved in 10 Cc. of water, a few drops of a saturated, aqueous solution of iodic acid added, and the mixture shaken with 2 Cc. of chloroform, the chloroform layer should not be colored violet (absence of *morphine salts*).

If 0.1 Gm. of finely-powdered thebaine hydrochloride be shaken with 10 Cc. of a 5 per cent. solution of potassium hydroxide, the mixture allowed to stand for an hour, filtered, and 2 Cc. of ammonium chloride solution added to the filtrate, no crystals should separate within 24 hours (absence of *morphine salts*).

If 0.1 Gm. of thebaine hydrochloride be dissolved in 40 Cc. of water, a few drops of freshly-prepared potassium ferricyanide solution added, and the mixture shaken, a yellow precipitate should not form within 10 minutes (limit of *papaverine salts*).

If 0.1 Gm. of thebaine hydrochloride be dissolved in 10 Cc. of water and a few drops of hydrochloric acid added, the solution should not at once became turbid on the addition of barium chloride solution (limit of *sulphate*).

If from 0.2 to 0.3 Gm. of thebaine hydrochloride be weighed and the salt burned, the ash should not exceed 0.1 per cent. of the weight taken.

If from 0.2 to 0.3 Gm. of thebaine hydrochloride be weighed, dissolved in 25 Cc. of water, a slight excess of ammonia water added, the mixture shaken with three successive portions of 25 Cc. each of ether, or a sufficient quantity to complete the extraction, the combined ether solutions washed with water, evaporated, the residue dried to constant weight at 100° C. and weighed, the weight found should correspond to not less than 84.5 per cent of anhydrous thebaine. The alkaloid obtained by this process should melt at 192.5 to 193.5° C.

Appendix I.

The Opium Alkaloids and the Approximate Percentages in which They Occur in Smyrna Opium.[18]

Name	Formula	Approximate percentage in Smyrna opium
Morphine	$C_{17}H_{19}O_3N$	9.00–10.00
Narcotine	$C_{22}H_{23}O_7N$	5.00
Papaverine	$C_{20}H_{21}O_4N$	0.80
Thebaine	$C_{19}H_{21}O_3N$	0.40
Codeine	$C_{18}H_{21}O_3N$	0.30–0.4
Narceine	$C_{23}H_{27}O_8N$	0.20
Cryptopine	$C_{21}H_{23}O_5N$	0.08
Pseudo-morphine	$(C_{17}H_{18}O_3N)_2$	0.02
Laudanine	$C_{20}H_{25}O_4N$	0.01
Lanthopine	$C_{23}H_{25}O_4N$	0.006
Protopine	$C_{20}H_{19}O_5N$	0.003
Codamine	$C_{20}H_{25}O_4N$	0.002
Tritopine	$(C_{21}H_{27}O_2N)_2O$	0.0015
Laudanosine	$C_{21}H_{27}O_4N$	0.0008
Gnoscopine (dl-narcotine)	$C_{22}H_{23}O_7N$	traces
Hydrocotarnine[19]	$C_{12}H_{15}O_3N$	traces
Hydroxy-codeine	$C_{18}H_{21}O_4N$	traces
Laudanidine	$C_{20}H_{25}O_4N$	traces
Meconidine	$C_{21}H_{23}O_4N$	traces
Oxynarcotine	$C_{22}H_{23}O_8N$	traces
Papaveramine	$C_{21}H_{25}O_6N$	traces
Proto-papaverine	$C_{19}H_{19}O_4N$	traces
Pseudo-papaverine	$C_{21}H_{21}O_4N$	traces
Rheadine	$C_{21}H_{21}O_6N$	traces
Xanthaline (papaveraldine)[19]	$C_{20}H_{19}O_5N$	traces

[18] Henry, "The Plant Alkaloids," 199 (1913).
[19] These are possibly decomposition products of narcotine and papaverine, respectively.

Appendix II.

Color Reactions of Some of the Opium Bases.

Alkaloid	Nitric acid (sp. gr. 1.42)	Sulphuric acid	Sulphuric acid plus dilute nitric acid; Erdman's reagent	Sulphuric acid plus formaldehyde; Marquis' reagent	Sulphuric acid plus iodic acid; Peroni's reagent	Sulphuric acid plus molybdic acid; Fröhde's reagent	Sulphuric acid plus selenious acid; Lafon's reagent	Sulphuric acid plus vanadic acid; Mandelin's reagent
Codeine...	Yellow, not changing to red	No color or faint transient pinkish; dirty brownish green on heating	Blue on warming	Violet; cherry red on long standing	Moss green, changing to slate; finally orange	Dirty green changing to blue and pale yellow	Green, changing to blue; then slowly to grass green	Pale green; gradually changes to blue.
Morphine.	Orange red, turning yellow on heating	Cold, no color or faint pink; on heating, variable	Orange brown	Intense purple	Violet, soon becoming brown	Intense purple; yellow and blue streaks or zones; finally green	Blue, changing to green; then to brown	Bluish violet, slowly becoming dark brown.
Narceine..	Yellow, rapidly fading	Brown, dissolving to yellow solution; changing to dark red on warming	Brown yellow, becoming mahogany brown on heating	Yellowish brown, soon becoming brown; green after some time	Chocolate brown	Brownish green changing to yellow and reddish yellow brown to blue	Light brown	Brown, changing to bluish violet; finally reddish brown.
Narcotine .	Yellow	Darkens, on gentle heating, to orange and brick red; violet, on boiling	On warming, pink, changing to blood red	Fugitive purple; pale violet, soon fading to slate; then orange with red zones; finally brown	Reddish brown and eventually cherry-red	Yellowish green, changing to green with blue streaks or zones; finally blue	Green, changing to greenish blue; violet blue; then brown and finally cherry red	Orange, changing to red.
Papaverine	Yellow	No color if pure; violet on heating	No color if pure	Yellowish green; deep rose and finally brown	Purple; immediately becomes streaked with brown	No color if pure	Pale green, changing to greenish blue; olive green; chocolate	Pale green; slowly changing to a bluish violet.
Thebaine .	Yellow	Blood red, turning orange yellow; olive green on heating	Orange red	Red	Red	Blood red, turning orange yellow and colorless	Blood red	Red.

SOME AMERICAN CONTRIBUTIONS TO INDUSTRIAL CHEMISTRY.[1]

By Samuel P. Sadtler, Ph.D.

You will notice that I have limited the subject matter of my brief address to what I call American Contributions to the Field of Industrial Chemistry. And even this field I will restrict by leaving to one side the discussion of what we have contributed to well-established industries of European origin, or how we have worked on lines already clearly mapped out for us by the prior establishment and successful operation of those industries abroad.

I do not wish to say that such contributions of American Chemists to some of the older and long-established industries have been of so slight a value as to be unworthy of mention. On the contrary, the part that American chemists and engineers have taken in the development of some of the older industries, such as the manufacture of acids, alkalies, and of heavy chemicals, of pigments of soaps and glycerin, paper-making, leather manufacture, and certain metallurgical lines, has been quite important. Most of this has received deserved recognition in the series of reports prepared within the last year for the Industrial Division of the American Chemical Society and published in its *Journal of Industrial and Engineering Chemistry*.

However, there are some very important chemical industries that took their start with us in this country and have been developed, too, in most cases, to flourishing condition without borrowing any notable help from abroad. These we should point out to those of the public who have not learned that we have anything distinctively our own as yet, and who think that because we cannot command our ante-bellum supplies of potash and organic dye-colors at present we must start in and establish the manufacture of chemicals as a new venture for this country.

With the wonderful richness of this country in the raw materials which lie at the basis of chemical industries, and with the well-known inventive and mechanical turn of our people, we would be greatly disappointed if we did not find some results in the way of the establishment of new and distinctive lines of manufacture

[1] Address before the National Exposition of Chemical Industries, held at New York, September 24, 1915.

and the production of new products for which uses were speedily found. We desire to make, this evening, brief reference to some of these American-developed chemical industries.

The first to note chronologically as well as the first in importance is the great petroleum industry. Isolated occurrences of natural oils, combustible in character, had been observed in various parts of the world, just as natural gas had been noted as a matter of interest to the mineralogist and to the traveller. For instance, in 1833, the elder Silliman and, in 1836, Dr. S. P. Hildreth described the occurrence of oil springs. From the surface of these the Indians had collected what was called Seneca oil. I have myself a pint sample of such oil from a spring in Ohio that is reported locally to have yielded oil from 1813 to the present. The Rock Oil Company, which afterwards became the Seneca Oil Company, had engaged Col. E. L. Drake as its manager, and on August 28, 1859, he struck oil at a depth of 69 feet in a well that he had drilled near Titusville, Pa., which started off with a daily yield of 25 barrels. From this mustard-seed has grown the great American petroleum industry, which in 1914 produced 265,762,535 barrels or 66.36 per cent. of the world's production.

However, it is not simply a question of being first in the discovery of how to obtain the oil from its subterranean deposits. The distillation of the crude oil for the purpose of separating the lighter from the heavier portions and refining them so that they could be used as burning oils, lubricating oils, etc., was developed entirely independently in this country. The distilling of shale oil and the preparation of a merchantable product for use as an illuminant under the name of "coal-oil" had already been practised when Drake's discovery was announced and petroleum distilleries speedily sprang up. Then the accidental discovery, as it is claimed, of the possibilities of increasing the yield of light fractions by what is known as "cracking," about 1865, made it possible to get a maximum yield of kerosene fraction from the crude.

When, later, the large production of a crude oil in California, differing greatly from the Pennsylvania crude first developed industrially, led to the establishment of the distinction between paraffin-base crudes and asphalt-base crudes, the preparation of an artificial asphalt from California oil followed.

Because of the large utilization of asphaltic materials for paving, roofing, waterproofing, etc., the manufacture of artificial asphalts

by the blowing of hot oil residuums generally, according to either the Byerley or the Culmer patents, followed, and it is now possible to get, in this way, solid products of every grade of ductility and penetration and a wide range of melting-point which find a great variety of uses.

It must not be overlooked that the industry owes much also to the engineering ability of the men connected with its early development. The enormous extent of the producing field would have made the question of the transportation very serious had not the tank car and the pipe-line soon developed to relieve them. These were the fruit of American invention, while the Russian oil industry is to be credited with the introduction of the oil-tank steamer now in general use.

I have referred to the early use of "cracking," as practised in the handling of the crude oil stills of most refineries in order to increase the burning oil fraction at the expense of the heavy oils. This has been followed by efforts to increase notably the gasoline or light naphtha percentage, which in recent years has become more important and commands a higher price than the burning oil. In place of the cracking by causing condensed heavy vapors to drop back upon a superheated oil layer in the still, but working under normal pressure, which involves much waste by formation of uncondensable gas and separation of carbon, recourse was had to distillation under pressure, as in the Burton process, now largely used by the Standard Oil Company in several of its largest refineries and with a considerable measure of success. Still more recently the principle of distillation under heavy pressure and at higher temperatures has been brilliantly applied by Dr. Rittman, with the result of the production of large amounts of gasoline or, at higher pressures, of benzene and toluene (aromatic hydrocarbons) in notable amount. This process is now being given a large-scale experimental trial by the Ætna Chemical Company, of Pittsburgh.

A somewhat similar process of decomposition of petroleum by heating under very high pressure has been described in outline by Walter O. Snelling, but the full account of the method and results has not as yet been published.

Radically different from these processes of cracking under pressure is the recently-described process of McAfee, who utilizes the Friedel and Crafts reaction with anhydrous aluminum chloride and, after getting off the normally present gasoline and kerosene, runs the

distillation of the heavy oils at about 500° to 550° F. with the aluminum chloride, obtaining, as a result, saturated hydrocarbons in both the gasoline and kerosene fractions produced. Mr. McAfee's paper has just recently appeared in both *Metallurgical and Chemical Engineering* and *Journal of Industrial and Engineering Chemistry,* and is worth careful study. I heard him give an account of his results at the San Francisco meeting of the American Institute of Chemical Engineers, and examined his samples of oils as used and obtained in his work.

My account of the American development of the petroleum industry would be incomplete did I not mention the rapid development of the production of gasoline by the condensation of natural gas accompanying crude petroleum, or what is called "casing-head gas." Bulletin No. 88 of the Bureau of Mines, Department of the Interior, on "The Condensation of Gasoline from Natural Gas," by Burrell, Seibert, and Oberfell, issued this year, gives a very complete picture of this new industry. I merely give the summaries of amounts of gasoline so produced in recent years: 1912, 12,081,179 gallons; 1913, 24,060,817 gallons. Of course, this gasoline with a gravity of 85° to 90° B. is reduced by blending it with naphtha distillate.

A second great industry developed in this country is the working up of native rock phosphate of lime into a fertilizer product. Of course, the value of phosphoric acid as an element in the fertilization of the soil was already indicated by Liebig, the great chemical founder of scientific agriculture, and the use of the rich native phosphates known as guano was extensively followed. But the opening up of the South Carolina phosphate rock beds in 1870, followed by the discovery of the still more abundant deposits of Florida in 1888 and of Tennessee in 1893, furnished the material for what was practically a new and American industry. The mining of rock phosphate and the manufacture of superphosphate fertilizers henceforth went hand in hand, with the result that one of the great chemical industries of America was developed. Reckoned by tonnage of products, it is the largest of our chemical industries, and it is important, too, as consuming fully one-half of the American sulphuric acid production, far exceeding all other industries in this respect.

I shall not take the time here to trace the development of this industry, but would like to add a few words to show the magnitude of our resources in raw materials in this line.

Dr. H. K. Benson, in his paper, read at the recent Seattle meeting of the American Chemical Society, on the "Resources of the Northwest," said that the phosphate deposits of Idaho were thirty times greater than the other deposits in the United States. The United States Geological Survey estimates that these Idaho deposits contain 2500 million tons of phosphate rock with 35 to 37 per cent. P_2O_5.

Related to this phosphate fertilizer industry is our utilization of animal scrap and waste for analogous use as fertilizer material. I will note three principal sources of supply of this material: First is the tankage and scrap of the great packing-houses at Chicago, Kansas City, Omaha, etc.; second, the menhaden fish residue of our Atlantic coast, after the oil has been extracted; and, third, the waste of the salmon and other fish-canning industries on the Pacific coast. With regard to this latter, Dr. H. K. Benson, in his paper on the "Resources of the Northwest," stated that from a packing of eight million cases of salmon in 1913, 140,210 tons of cannery waste was obtained. Of the amount of material from the other sources named I have no present information.

Another great industry, while not created *de novo,* has been profoundly modified by an American invention which was developed and in use here for years before it was taken up abroad. I refer to the water-gas manufacture. This was the invention of Thaddeus S. C. Lowe, who had already established a creditable reputation as a military aëronaut in our Civil War. The Lowe water-gas process of 1872–5 afterwards was acquired by the United Gas Improvement Company of Philadelphia and underlies the present large manufacture of this type of gas, whether carburetted or otherwise, which is practised in this country and in Europe upon the continent. The Germans followed in 1886, and with an improved form of apparatus in 1895.

More recently we have seen another old-established chemical industry revolutionized by an American invention, which had the effect of establishing what might be called a new and highly successful American industry. I refer to the American production of sulphur in Louisiana by the aid of the Frasch process of extraction of the sulphur in melted form by pumping it from the depths where it is found. This American production of a nearly pure native sulphur has completely stopped the importation of Sicilian sulphur, and

was, at the outbreak of the present war, competing with the Sicilian product in Mediterranean ports.

We have two distinctively American products in the vegetable kingdom which serve to furnish the starting-point or raw materials for two highly-developed American chemical industries, viz., the cotton plant, furnishing the cotton seed and its products, and the maize or Indian corn, furnishing corn starch and its alteration products, corn oil and gluten.

The cotton seed and its products have become among the most valued assets of the cotton planter. From each ton of cotton seed over 300 pound (40 to 50 gallons) of oil can be obtained, which, when properly refined, furnishes us one of our most valuable oils, both for technical use, as soap stock, and for food purposes. Hundreds of mills throughout the South are engaged in pressing this cotton oil, as it is called; enormous quantities have gone to be blended with stearine to make so-called compound or substitute lard, and other large amounts brought to a white, deodorized condition, used directly for food and baking purposes. More recently it has been converted into a soft, white, solid condition by the hydrogenating treatment, and in that form is again available as an edible oil for cooking and baking. After the expulsion of the oil, we have left the oil-cake, which, ground to meal, makes a very valuable feeding stuff or addition to fertilizers because of its nitrogen content. The hulls, burned as fuel, yield an ash rich in potash and phosphoric acid, hence of immediate value in the making up of fertilizers. The success with which the cotton seed, at one time a waste product, after the removal of the seed hair or valuable fibre by ginning, has been turned into a source of wealth for a great section of our country, illustrates how a great chemical industry was built up and values created out of material at first entirely neglected. The other distinctively American industry that I coupled with the cotton seed industry was the utilization of maize or Indian corn, and has come to be known generally as the corn products industry.

While the starch production from wheat, potatoes, and rice had been worked out elsewhere, and while a hydrolyzed product of syrupy consistency had also been obtained from potato starch, the manufacture of corn starch and of corn syrup, the latter first known as glucose, was worked out in this country, and upon and around this has been built up a great industry, producing a great range of products of great commercial importance. Corn starch was manu-

factured in this country as early as 1848, at Oswego, N. Y., but until about 1881 little but the starch itself was recovered or sought to be recovered. To-day, besides recovering the starch in a high state of purity, the germ is made to yield the valuable corn oil and an oil-cake for cattle feeding; the gluten is recovered in a dry state and, mixed with the ground hulls, makes a nitrogenous cattle food. The extractive matter (or corn-solubles) from the steep water is now also saved and incorporated with the gluten feed. The starch may be marketed as dry starch of various grades and prepared for a variety of uses, as dextrines of various colors and qualities, or as more or less hydrolyzed products, known as corn sugar and corn syrup. The oil is used in the manufacture of soap, soap powders, in the tanning industry and in paint, and, what is of interest, affords, when vulcanized, an excellent rubber auxiliary or rubber imitation. It is also a source of glycerin, while the free fatty acids find ready use by the soapmaker. In fact, this industry, in its present-day development, is one of the best illustrations of a scientific American chemical industry, working up a distinctive American raw material in the most complete way.

Without looking around for further individual illustrations of American-developed chemical industries, we now turn to a group of industries of American founding and developing which have taken a great lead in the world's industrial progress. I refer to the part which America has played in the electro-chemical and electro-metallurgical industries, several of the most important of which are based upon the discoveries of American chemists and have been brought to a high state of development by their continued effort.

The first of these American inventions was the Hall aluminum process, dating back to 1886, the date of his patent application. This fundamental discovery of the method of electrolyzing alumina dissolved in a bath of fused cryolite has now supplanted all other methods, and the manufacture of metallic aluminum everywhere throughout the world is practically based upon it. What is of more importance for our present argument is that a great American industry has developed from it and we have become the leaders in the manufacture of this important metal because of it. The history of this discovery has been repeatedly told and the importance of aluminum in the arts has been pointed out, so I will not dwell upon that side of the subject.

We have next two important industries, both based upon the

discoveries of an American chemist. I refer to the carborundum industry and the manufacture of artificial graphite, both based upon the discoveries of Dr. E. G. Acheson and now flourishing lines of manufacture at Niagara Falls, N. Y. The carborundum or silicon carbide is formed in the electric furnace and finds an extensive use as an abrasive under a great variety of forms, having a hardness almost equal to that of the diamond. The artificial graphite is a product of a reaction similar to that indicated for carborundum, but carried through at a higher temperature, whereby the silicon is evaporated, leaving the residual pure carbon as soft metallic graphite This latter is so free from impurity that it may serve as the basis of the finest lubricating mixtures. These specially-prepared lubricants, known as aquedag and oildag, according as they are brought in suspension in water or oil admixture, have proved of special value.

One of the great industries based upon electric furnace work is the manufacture of calcium carbide, which in itself, as a source of acetylene and as the necessary material for use in other great industries, as the cyanamide manufacture, is now produced throughout the world in large and increasing amount. While calcium carbide as a chemical compound had been discovered by Wöhler in 1862, and while Moissan had obtained it in his electric furnace independently about the same date as Wilson, the production of it by electric furnace reaction on a working scale was due to Wilson at Spray, N. C., in 1892, who may therefore be said to have founded the calcium carbide industry. This industry has spread to all countries where cheap water power is available for the generation of electricity, and in this country is strongly established at Niagara Falls and at Sault Ste. Marie, besides the use above referred to in the manufacture of calcium cyanamide, which has also been started in this country.

The manufacture of electrolytic caustic soda and chlorine has also had a very creditable showing in this country in recent years, and in this connection several American types of cells have been successful. I refer to the Castner electrolytic cell, which has operated successfully for a term of years, and the Townsend cell, of more recent development. By the aid of these inventions it has been made possible to establish at Niagara Falls several flourishing chemical industries and to give an impetus to the movement for the emancipation of the United States from dependence on European chemical manufacture.

I have thus sketched the development and establishment of a number of chemical industries of distinctively American origin. My list is not intended to be an exhaustive one. It could readily have been extended. It is enough, however, to show that we have done very creditably and, in fact, have done much more than is generally known to the public.

As I said in beginning these remarks, "With the wonderful richness of this country in the raw materials which lie at the basis of chemical industries, and with the well-known inventive and mechanical turn of our people, we would be greatly disappointed if we did not find some results in the way of the establishment of new and distinctive lines of manufacture and the production of new products."

So much for the establishment of new industries. However, unless the supply of raw materials is so specially limited to the country as to preclude their becoming available elsewhere, a time will come for an important industry when the manufacture becomes competitive in an international sense. Then a national policy with regard to established industries becomes of the greatest importance. Legislation can foster these industries in a great variety of ways, or it can hamper them so that international competition soon puts them at a disadvantage.

If we are to maintain our chemical manufactures already begun and reach out for a stronger and more independent position in industrial chemistry, the matters of legislation, the tariff, and our patent laws must be given intelligent thought and such action taken as will give us a fair show in the world's competition. As that is a large subject, involving many considerations, I will not enter upon it here.

THE EXAMINATION OF CHAULMOOGRA OIL.

By Probodha C. Chattopadhyay, M.A., F.C.S.,
Chemist, Bengal Chemical and Pharmaceutical Works, Ltd., Calcutta.

Botanical Observations.

Chaulmoogra oil of commerce is obtained from a large variety of seeds. According to the Indian and Colonial Addendum (1900) to the British Pharmacopœia (1898), the oil is expressed from the seeds of *Gynocardia odorata*. But subsequent identification by Colonel Prain proved that the oil is really obtained from the seeds

of *Taraktogenos Kurzii,* King (Fam. *Bixineæ*), a native of Burmah. The commercial oil is, however, also made from another variety of seeds, *false* chalmoogra seeds, botanically known as *Gynocardia odorata* or, more correctly, *Chaulmoogra odorata,* which grows abundantly in Chittagong and Assam. Various other seeds give oil similar to chaulmoogra oil in physical and chemical properties. Their names are given below.

1. *Hydnocarpus Wightiana* or *Hydrocarpus Wightiana,* indigenous to Southern India.
2. *Hydnocarpus anthelmintica,* indigenous to Siam.
3. *Oncoba echinata,* obtainable from Sierra Leone, Africa.

The chaulmoogra seeds bought from various shopkeepers in the local market were examined and all of them were found to be *Gynocardia odorata.*

Samples of the oil examined by me were obtained from two sources, one from Messrs. B. K. Paul & Co., and the other from Messrs. Smith, Stanistreet & Co., both of Calcutta.

Messrs. B. K. Paul & Co. are one of the oldest manufacturers of this oil, and their product is of a pale brownish-yellow color, of the consistency of butter, and sometimes it is semi-liquid, being a mixture of liquid and solid product, the white, crystalline solid matter separating from the reddish liquid portion on standing. This oil is said to be obtained from genuine seeds by *expression by the hot process,* but subsequent examination makes it doubtful if it is actually made from *unmixed* seeds of the true chaulmoogra (*Taraktogenos*). As I could not get the seeds actually used by the firm, no further observation can be made on it.

The oil supplied by Messrs. Smith, Stanistreet & Co. is manufactured by the Indian Forests Economic Products Company, Ltd., of Chittagong. Chaulmoogra oil manufactured by this firm is guaranteed by their technical expert, Mr. E. E. Francis, M.R.C.S., to be "pure *cold drawn oil* expressed from the seeds of *Taraktogenos Kurzii,*" they having exclusive rights for the collection of these seeds from the government. The oil is of a pale sherry color, and *is liquid at ordinary temperatures and remains so even at 15° C.*

All European observers describe genuine chaulmoogra oil as a soft solid of varying consistency (melting-point 22–23° C.). Indeed, Dr. Power and Mr. M. Barrowcliff,[1] in their paper on the

[1] *J. C. S.,* 1905, 896.

examination of the oil of *Gynocardia odorata,* remark that the oil of Gynocardia seeds is a liquid, whereas the chaulmoogra oil of commerce (*i.e.,* that made from taraktogenos seeds) is a solid. Now their observations are quite at variance with those obtained by the examination of genuine oil from the Indian Forests Products Company (if we take their guarantee to be true—and we have no reason to believe otherwise).

The above botanical notes show that the matter is in an unsatisfactory condition as to the exact source of chaulmoogra oil. The various analyses by different observers support this view.

In my opinion, the oil of genuine taraktogenos seeds expressed by cold process is *liquid* at ordinary temperatures, and the oil obtained by hot expression of these seeds is solid or semi-solid, whereas the oil from Gynocardia seeds is probably semi-solid, whether obtained by cold or hot process. These observations I will confirm as soon as I get the genuine seeds.

Previous Workers.

The oil from various seeds had previously been examined by John Moss,[2] E. Heckel and F. Schlagdenhauffen,[3] A. Petit,[4] A. H. Allen, J. Schindelmeiser,[5] F. B. Power and F. H. Gornell,[6] E. Herschohn, F. B. Power, and T. H. Lees,[7] Power and Barrowcliff,[8] and Pabisch.[9] Of these, the papers of Dr. Power and his collaborators give the latest information on these oils. The results of Pabisch are merely a copy of Dr. Power's researches.

The oil of *Oncoba echinata* has been examined by E. Goulding and N. C. Akers.[10]

The results of all these observations differ from one another and also from my own observations in many respects. They are given in the form of a table at the end of this paper.

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[2] "Year book of Pharmacy," 1879, 523–533.
[3] *Journal de Pharmacie et de Chimie,* 1885.
[4] *Journal de Pharmacie et de Chimie,* 1892, 445.
[5] *Apoth. Zeit.,* 1904, 306.
[6] *J. C. S.,* 1904.
[7] *J. C. S.,* 1905, 349.
[8] *Ibid.,* 1904, 884–896.
[9] *Pharm. Post,* 1903.
[10] *Proc. C. S.,* 1913,197–198.

Analysis.

As stated before, two different kinds of oils were examined:

1. Oil from *Taraktogenos Kurzii* seed, manufactured by the Indian Forests Products Company.

2. Oil containing solid fat and liquid product, manufactured by Messrs. B. K. Paul & Co. This oil was filtered and the solid fat (amounting to about 50 per cent. of the total) removed. The clear filtered oil (*a*), and the separated fat (*b*) were separately examined.

In this paper they are designated as follows:

1. Smith oil.

2. (*a*) B. K. Paul oil; (*b*) chaulmoogra fat.

The temperature of the laboratory throughout the time the experiments were conducted was 30° C.

Examination of the Oils.

1. Smith Oil.—The oil was of a pale yellow color, with a disagreeable taste and smell. Sp. gr. 0.9488 at 30° C. The solidifying point by the titre test was found to be 11.9° C., and it remained liquid at 15° C. The oil is acid to litmus, acidity being due to the presence of about 11 per cent. of free acid expressed as oleic acid (see acid value, *infra*).

2. (*a*) B. K. Paul Oil.—The oil had a pale brownish color, somewhat darker than the other oil. The odor was also more intense than in the case of the other oil. Sp. gr. 0.9471 at 30° C. The oil gave two solidifying points by the titre test, viz., 21.5° C. and 27° C. The oil is solid at 15° C. and liquid at 30° C. At intermediate temperatures different quantities of crystalline solids are deposited. The oil was strongly acid to litmus, acidity being due to the presence of a large quantity of free acid (about 44 per cent. expressed as oleic acid) (*infra*).

2. (*b*) Chaulmoogra Fat.—The solid fat, after draining in the filter paper for seven days, was pressed through cloth to remove adhering oils, and then examined. It was a white, crystalline solid, the solidifying point being by the titre test 33° C. The reaction was strongly acid to litmus, the acid value, in terms of percentage of oleic acid, being as high as 59. This shows that it is composed almost wholly of free fatty acids.

(*A*) Color Reaction with Sulphuric Acid.—Ten drops of

the oil were placed on a porcelain tile and one drop of sulphuric acid was added. On stirring with a glass rod the following changes of color were noticed:

(1) *Smith oil* gave a yellow coloration, which changed rapidly to reddish-brown and finally to dirty brown. If five drops of oil be mixed with five drops of sulphuric acid, then the same colorations are noted, but the oil is converted into a resinous mass.

(2) *B. K. Paul oil* passed through the same changes of color, but finally it acquired an olive green tint. The mixture of oil and sulphuric acid remains fluid when equal parts of oil and acid were mixed.

(3) *Acid obtained from Smith oil,* when similarly treated, gave a yellow, then reddish-brown, dirty brown, and, after some time, a dirty green color.

(4) *Acid obtained from B. K. Paul oil* under similar conditions gave a yellow, then reddish-brown, dirty brown, and finally a dirty green color, the latter coloration coming out more quickly than in the case of the other acids.

(5) *Chaulmoogra fat* gave changes of color similar to *B. K. Paul oil,* the product remaining liquid.

N. B.—The coloration with strong sulphuric acid may therefore be used to *distinguish the two kinds of oils.*

(*B*) MAUMENE NUMBER.—The rise of temperature by the action of 50 grammes of oil and 10 Cc. pure concentrated sulphuric acid was recorded. Thus: (1) Smith oil, 86° C.; (2) B. K. Paul oil, 83.5° C. During the reaction there was evolution of sulphur dioxide, the oil being converted into a tough, resinous mass.

(*C*) VALENTA TEST.—Five cubic centimetres of oil were mixed with 5 Cc. of pure glacial acetic acid and the temperature of turbidity noted. Thus it was found: (1) Valenta test of *Smith oil,* 101° C. (2) In case of *B. K. Paul oil* it completely dissolved in the acid at ordinary temperature, so Valenta test could not be carried. It was further found that at ordinary temperatures the oil is miscible in any proportion with up to double its volume of glacial acetic acid. If more acid is added above this, then the liquid becomes turbid. The oil is, however, miscible with slightly warm acetic acid in any proportions. (3) The *chaulmoogra fat* was also found to be readily soluble in glacial acetic acid.

Hence it is concluded that the solubility of B. K. Paul oil in glacial acetic acid is due to the presence in it of a large quantity of

free fatty acids (see *infra*). This test can also be used to distinguish the two oils.

(*D*) FREE FATTY ACIDS: ACID VALUE.—The reaction of both samples of oil, as previously stated, was acid to litmus; the acid value was determined according to Lewkowitsch method.

(1) *Smith oil.*—5.4204 grammes of oil taken. Required for neutralization 21.5 Cc. $\frac{N}{10}$ NaOH (corrected). Therefore milligrammes of KOH required for neutralizing 1 gramme of oil or its acid value $= \frac{21.5 \times 5.61}{5.4204} = 22.1$. Acid number or number of cubic centimetres of decinormal alkali required to neutralize free acid in 1 gramme of oil $= \frac{21.5}{5.4204} = 3.94$. Free fatty acids expressed as oleic acid per cent. $= \frac{21.5 \times .0282 \times 100}{5.4204} = 11.18$.

(2) *B. K. Paul oil.*—3.1762 grammes of oil required for neutralization 50 Cc. $\frac{N}{10}$ NaOH (corrected).

Therefore acid value (mgrms. KOH) $= \frac{50 \times 5.61}{3.1762} = 88.3$. Acid number $= \frac{50}{3.1762} = 15.7$. Free fatty acids as oleic acid per cent. $= \frac{50 \times .0282 \times 100}{3.1762} = 44.39$.

(3) *Chaulmoogra fat.*—2.8886 grammes of acid required for neutralization 60.6 Cc. $\frac{N}{10}$ NaOH. Therefore acid value $= \frac{60.6 \times 5.61}{2.8886} = 117.69$. Acid number $= \frac{60.6}{2.8886} = 20.98$. Free fatty acid as oleic acid per cent. $= \frac{60.6 \times .0282 \times 100}{2.8886} = 59.16$.

(*E*) SAPONIFICATION VALUE.—The saponification value was determined according to the method described in Lewkowitsch.

(1) *Smith oil.*—1.2396 grammes of oil were taken after saponification with 25 Cc. Köttstorfer solution required for neutralization of excess of alkali 23.5 Cc. half-normal HCl (cor.). 25 Cc. Köttstorfer solution = 33.5 Cc. $\frac{N}{2}$ HCl. Therefore, saponification value $= \frac{(33.5 - 23.5) \times 28.06}{1.2396} = \frac{280.6}{1.2396} = 226.36$.

Another sample gave 224.55.

(2) *B. K. Paul Oil.*—1.2510 grammes of oil taken. After saponification 23.8 Cc. semi-normal acid was required to neutralize. Therefore, saponification value $= \frac{(33.5 - 23.8) \times 28.06}{1.2510} = \frac{.182}{1.2510} =$ 217.57.

(3) *Chaulmoogra Fat.*—1.4748 grammes required 21.5 Cc. acid. Therefore, saponification value $= \frac{(33.5-21.5)\times 28.06}{1.4748} = \frac{336.72}{1.4748} = 228.3$.

(*F*) HÜBL VALUE.—The method of above quoted authority was followed. Only 25 Cc. of Hübl solution was used instead of 30 Cc.

(1) *Smith Oil.*—0.2314 gramme of oil taken. After three hours' action 26.7 Cc. decinormal thiosulphate solution were required for excess of iodine. Blank experiment required 44.3 Cc. thiosulphate solution. Therefore Hübl value $= \frac{17.6 \times .0127 \times 100}{.2314} = 96.58$.

Another sample gave 94.67.

(2) *B. K. Paul Oil.*—0.2830 gramme of oil taken. 20.8 Cc. thiosulphate solution were required. Therefore Hübl value $= \frac{23.5 \times .0127 \times 100}{.2830} =$

$$\frac{.2985 \times 100}{.2830} = 105.47.$$

Another sample gave 101.87.

(3) *Chaulmoogra Fat.*—0.3294 gramme taken. 17.5 Cc. thiosulphate solution were required to neutralize iodine. Blank experiment required 44.3 Cc. iodine. Therefore Hübl value $= \frac{26.8 \times .0127 \times 100}{.3294} = 103.3$.

Another sample gave 105.39.

(*G*) ACETYL VALUE.—The acetyl value was determined according to the Lewkowitsch process, the final determination being made by the filtration method.

(1) *Smith Oil.*—10.68 grammes of oil were acetylated with 15 Cc. acetic anhydride. 1.9006 grammes of dry acetylated oil, after boiling with 25 Cc. Köttstorfer solution and neutralization with exact quantity of standard acid, required 6.5 Cc. decinormal alkali to neutralize excess acid. Therefore acetyl value $= \frac{6.5 \times 5.61}{1.9006} =$ 19.1.

(2) *B. K. Paul Oil.*—8.57 grammes of oil were acetylated. 2.2858 grammes of acetylated oil required 16.26 Cc. NaOH. Therefore acetyl value $= \frac{16.26 \times 5.61}{2.2858} = 39.9$.

The low acetyl value proves the absence of hydroxy acids and further indicates that the fatty acids are present in the oil almost wholly as triglycerides. In the case of B. K. Paul oil, there may have been some decomposition, indicating the rancidity of the oil. This may be due to the expression of the oil by the hot process.

(*H*) SAPONIFICATION VALUE OF ACETYLATED OIL.—This value is also known as "Benedikt's acetyl acid value," and was obtained by determining the saponification value of the acetylated oil with phenolpthaline as indicator.

(1) *Smith Oil.*—1.4856 grammes acetylated oil taken. After saponification 11.1 Cc. semi-normal acid were required to neutralize the excess of alkali. Therefore the Benedikt value = $\frac{(33.5 - 11.1) \times 28.06}{1.4858} = 423.07$.

(2) *B. K. Paul Oil.*—1.9664 grammes of acetylated oil taken. 14.7 Cc. standard acid was required. Therefore Benedikt value = $\frac{18.8 \times 28.06}{1.9664} = \frac{527.828}{1.9660} = 268.2$.

The high Benedikt value shows the presence of triglycerides in Smith oil and confirms the previous statement.

(*I*) ESTER VALUE.—This is the difference between acid value and saponification value of the oil. In case of Smith oil it is 204.26, and in case of B. K. Paul oil it is 129.27.

The great difference between the ester value of the two oils once more confirms the view formerly expressed that Smith oil consists almost wholly of neutral ester (triglycerides), whereas the other oil is a mixture of tri- and di- glycerides.

N. B.—The ester value of the chaulmoogra fats was 110.6.

EXAMINATION OF FATTY ACIDS.

One hundred grammes of the oil were saponified with the calculated quantity of caustic potash dissolved in a mixture of 100 Cc. water and 50 Cc. alcohol and boiling under a reflux condenser. The fatty acids were then liberated by heating with excess of dilute sulphuric acid. The melted fatty acids floated on the surface of the water as an oil. After washing and cooling, both the acids were obtained in a white, crystalline mass and had a sweet odor suggesting that of the acid obtained from cocoanut oil. They could not be distinguished from one another by color, odor, or appearance.

(1) The fatty acids from Smith oil gave solidifying point by titre test at 36.5° C. The acid was recrystallized once from alcohol and then from benzene and the solidifying point again determined. It was found to be 37° C. The melting-point was the same as the solidifying point.

(2) The fatty acids from B. K. Paul oil gave solidifying point at 33° C. It was also recrystallized once from alcohol and then from benzene, but the solidifying point remained the same. The melting-point was also 33° C.

No acid of melting-point 68° C. could be isolated by fractional crystallization.

(*A*) SAPONIFICATION VALUE.—(1) *Fatty acid from Smith oil.* 1.0348 required for neutralization after saponification 25 Cc. semi-normal acid. Therefore saponification value =

$$\frac{(33.5 - 25) \times 28.06}{1.0348} = 230.48.$$

(2) *Fatty acid from B. K. Paul oil.* 1.1876 grammes of fatty acid required for neutralization after saponification 23.6 Cc. acid. Therefore saponification value = $\frac{(33.5-23.6)\times 28.06}{1.1876} = 233.9$.

(*B*) NEUTRALIZATION VALUE.—(1) *Acid from Smith oil.* 3.0178 grammes required 124.6 Cc. decinormal alkali solution. Therefore milligrammes of KOH required to neutralize 1 gramme of fatty acid or its neutralization number = $\frac{124.6 \times 5.61}{3.0178} = 231.6$.

(2) *Acid from B. K. Paul oil.* 3.7004 grammes of acid required 156.7 Cc. of decinormal alkali. Therefore neutralization value =

$$\frac{156.7 \times 5.61}{3.7004} = 237.5.$$

The difference between neutralization value and saponification value being small—0.16 in case of Smith acid and 3.6 in case of the other—proves the *absence of any lactones.*

(*C*) HÜBL VALUE.—(1) *Acid from Smith oil.* 0.3180 grammes of acid, after treatment with iodine solution, required 16.7 Cc. thiosulphate solution. Blank experiment required 41.3 Cc. thiosulphate. Therefore Hübl value = $\frac{(41.3 - 16.7) \times .0127 \times 100}{.3180} = 98.23$.

Another sample gave 94.26.

(2) *Acid from B. K. Paul oil.* 0.3094 grammes required 14.1 Cc. the sulphate solution. Therefore Hübl value =

$$\frac{(41.3 - 14.1) \times .0127 \times 100}{.3094} = \frac{345400}{3094} = 111.63.$$

Another sample gave 109.84.

The above quantitative examination, as also the physical properties, show that the fatty acids obtained from the two sources have very nearly the same composition.

Salts of Gynocardic Acid.

1. *Calcium Gynocardate.*—This was prepared by neutralizing the oil with alcoholic potash and precipitating the neutralized solution with a dilute solution of calcium chloride. A granular white precipitate was obtained which became plastic when boiled with water. It is soluble partly in boiling alcohol, and the solution, on cooling, deposits a large quantity of a jelly-like precipitate, which crystallizes on standing. The alcoholic solution separated by filtration when it became completely cold and was used for the detection of phytosterol according to the method of *Kreis and Wolff* (see Leach's "Food Inspection and Analysis"). The phytosterol was further identified by extracting the crude calcium salt with ether and preparing phytosteryl acetate by the method of Lewkowitsch. The calcium salt is slightly soluble in boiling water. A portion of the salt washed with ether was dried on a steam-bath. Those in contact with hot surface acquired a yellowish tint, the substance becoming semi-solid at the same time. A little of the salt taken in a test-tube and kept in a steam oven for six hours was converted into a brownish-yellow resinous substance with a characteristic odor, showing that the salt is decomposed by heat. On boiling a little of the salt with water in a test-tube it became plastic and at the same time acquired a strong yellow color. On cooling, a brittle, hard lump of resinous color was obtained. On dry heating, the salt decrepitates (due, perhaps, to the presence of water of crystallization in the salt) and then melts, acquiring a yellowish-brown color. On more heating, it turned reddish-brown and gave acrid-smelling white fumes. When cold water was added into the test-tube, the solution gave a neutral reaction with litmus paper and methyl orange.

2. *Zinc Gynocardate.*—Prepared in a similar manner by precipitating soap with zinc chloride solution. It is white and crystalline and becomes plastic on heating. But no coloration takes place. On dry heating the same change takes place as with calcium salts. It is insoluble in water and very slightly soluble in boiling alcohol.

3. *Magnesium Gynocardate.*—This salt is prepared as above described by precipitating the new neutral potash soap with magnesium chloride solution. The physical properties are similar to those of the zinc salts. It is slightly soluble in water, but more soluble in boiling alcohol than the calcium salt (compare lauric acid).

CONSTITUENTS OF GYNOCARDIC ACID.

The mean molecular weight of the acids calculated from the neutralization values gave 242 in case of Smith acid and 236 in case of the other acids. The high neutralization value (230) indicates the presence of saturated fatty acids of the general formula $C_nH_{2n}O_2$, and this, combined with the ready solubility of the calcium and magnesium salts in boiling alcohol, suggests the presence of lauric acid. Further, the ready decomposibility of the calcium salts, as also its solubility, makes the presence of linoleic acid very probable. The various quantitative determinations show that chaulmoogra oil is a mixed triglyceride of lauric, chaulmoogric, and linoleic acids. The approximate percentage composition calculated from these data gives the following:

	Per cent.
Linoleic acid (series $C_nH_{2n-4}O_2$)	70
Oleic acid (series $C_nH_{2n-2}O_2$)	28
Lauric acid (series $C_nH_{2n}O_2$)	12
	100

The examination of the other salts of the gynocardic acid, as also the detailed examination of the individual fatty acids, is in progress.

THE SAN FRANCISCO MEETING OF THE AMERICAN PHARMACEUTICAL ASSOCIATION.

BY JOSEPH W. ENGLAND, PH.M.

The sixty-third annual meeting of the American Pharmaceutical Association was held at the Exposition City during the week of August 9, 1915, and the "Land of Sunshine and Flowers" was true to its name. The weather was delightful, and the meetings, educationally, legislatively, scientifically, commercially, practically, historically, and socially, were full of interest, and a whole lot of real constructive work was done.

The total registration was about 250, which was a good showing in view of the distance from which many of the members came.

Excellent papers in all the sections were read, and the discussions were many and spirited. The committees were unusually active, and much new work was mapped out for the future.

Education was the topic most discussed. Beginning with the

meeting of the National Association of Boards of Pharmacy, at which a resolution was passed expressing the hope that by 1920 prerequisite legislation, based upon an entrance requirement of high-school graduation, would obtain in all the States; continued in the deliberations of the American Conference of Pharmaceutical Faculties, the subject was uppermost in the meetings of the association, and was especially prominent when President Mayo announced the establishment of a scholarship by S. W. Fairchild, of Fairchild Brothers and Foster, of $300 per year, to be awarded annually by a committee to consist of the presidents of the American Conference of Pharmaceutical Faculties, the National Association of Boards of Pharmacy, and the Editor of the *Journal of the American Pharmaceutical Association*. The recipient of the scholarship may select his own school. The details of the selection, however, have not yet been determined.

A pathetic feature of the meetings was the announcement that Prof. C. Lewis Diehl, for nearly forty years officer of the association and Reporter on the Progress of Pharmacy, is in failing health, which has rendered it impossible for him to carry on his work as Reporter on the Progress of Pharmacy with dispatch and as chairman of the Committee on National Formulary. In the first position a fitting successor was found for Professor Diehl in the person of Prof. Julius A. Koch, of Pittsburgh, who was made Reporter on the Progress of Pharmacy; while the Council directed Prof. Wilbur L. Scoville, of Detroit, to act as vice-chairman of the Committee on National Formulary, with power to act as chairman.

Genuine regret was felt that Professor Diehl's work must be concluded, and the association desires to honor him in all possible ways. An honorarium of $1000 was voted him for his work as chairman of the Committee on National Formulary and in bringing to press the fourth edition of the National Formulary.

A number of changes in the by-laws were made with the design of facilitating the business of the association. One of these was a change allowing a minimum of 15 local members to form a local branch, retaining the requirement of a minimum of 25 for representation on the Council.

The report of the Committee on Proprietary Medicines excited considerable interest. This report reviewed the status of proprietary remedies, and made ten recommendations of a general nature which may form a basis of action in the future. The committee

felt that slow and careful action was desirable, and did not attempt to suggest any detailed policy, but only to offer a basis on which future actions may be built.

The Committee on the Function of the House of Delegates recommended that no radical change be made at present. The report discussed the present functions of this body, and suggested changes that might be made in the future. Prof. H. P. Hynson, who has labored most zealously during the year on reform in the function and representation in the House of Delegates, was honored by election to the chairmanship of the House of Delegates for the coming year.

A new committee of fifteen members on Recipe Book was selected in place of the seven former members. The new committee will serve in sections of three for five years each, which will provide for a definite working committee and will doubtless result in the securing of satisfactory work.

A committee of five to submit to the American Medical Association a desire and plan for coöperation in mutual interests is to to be appointed by the incoming president; also a committee of five is to be appointed to investigate and report on fair and reasonable prices for prescriptions.

The association went on record as opposing the ruling of the Internal Revenue Commissioner that prescriptions containing the minimum quantities of narcotics under the Harrison law may not be refilled; also as opposing the continuation of the stamp tax on toilet preparations.

In the Scientific Section twenty-eight papers were presented, but only about one-third of the authors were present. Chairman Eberhardt's address was an exceedingly able one and dealt with the chemical manufacturing situation in America. As a result, a committee was appointed to consider our patent laws, and a resolution was passed calling upon Congress to encourage chemical industry by means of a protective tariff.

Interesting papers were presented by Wilbur L. Scoville, in which a comparison was made between tinctures made direct from drugs and those made by diluting the fluidextracts; by J. U. Lloyd, on a history of the discovery of the alkaloidal affinities of hydrous aluminum silicate, and by H. V. Arny, giving a demonstration of a method for standardizing colors by means of mixtures of semi-normal inorganic solutions.

The Section on Education and Legislation was unusually popular. It held a joint session with the Conference of Faculties and Boards of Pharmacy, at which three markedly valuable papers were presented by Professors Lloyd, Remington, and Alpers. Professor Lloyd's paper was on "Pharmaceutical Apprenticeship Fifty Years Ago;" Professor Remington's paper was upon "Coöperation a Necessity: Why is There Not Better Activity between the Medical and Pharmaceutical Professions in this Direction?" and Professor Arny's paper was on "Qualifications for Teachers in College of Pharmacy."

Another joint session was held with the Commercial Section, which proved to be very interesting. Papers treating of the mutual interests of pharmaceutical and commercial pharmacy were discussed. It was stated that professional pharmacy needs to make some connection with the needs of the people—and commercial pharmacy is the medium through which it must connect.

The Section on Education and Legislation had 27 papers and addresses on its programme and held five sessions.

The Section on Practical Pharmacy and Dispensing had few papers, but despite the briefness of its programme, only four papers being presented and the Chairman's address, the meeting was lively and profitable. Every paper read induced a spirited discussion.

The Section on Commercial Interests had twelve papers and a good attendance at its meetings, with frequent and animated discussions. Prescription pricing was the favorite topic, special emphasis being made in the discussions upon the money value of brain work and technical skill.

The Women's Section held its usual meetings, which were well attended. Papers were read and the enthusiasm was strong. This section is doing splendid work in getting new members for the association.

The Historical Section was admirably presided over by Prof. Eugene G. Eberle, in the absence of its chairman. By vote, the Editor of the *Journal of the American Pharmaceutical Association* is to be the permanent historian in the future. Fourteen papers were presented. An illustrated lecture on the spice trade of the sixteenth and seventeenth centuries was given by Prof. A. W. Linton.

On the recommendation of the Historical Section an effort will

be made to secure a picture and brief biographical sketch of each of the present and new members of the association and to preserve these for future use. Requests will be made for these by the officers of the association in the near future, and a general response is hoped for.

There is also to be a systematic filing of all matters of historical interest pertaining to the association.

The meetings of the American Conference of Pharmaceutical Faculties were highly satisfactory. Twenty-three faculties were represented. The dominating feature of the meetings was the exceedingly able and comprehensive address of Prof. F. J. Wulling. Its recommendations were referred to two separate committees, one to consider the relations outside of the schools and one those inside.

In the meetings of the National Association of Boards of Pharmacy there were nineteen delegates, representing thirteen different States. It was a harmonious meeting, not only in itself but also to every organization with which it held joint sessions. The consensus of opinion was that it would be better in the future to hold the sessions of the boards during the week that the American Pharmaceutical Association met, and not the week before.

Reciprocal registration was a subject which attracted the most attention, and, while no radical action was taken, yet there was shown a distinct attitude favorable to a more liberal policy in this direction and toward less stringent requirements than now prevail, particularly as regards statistics of the first registration.

The secretary reported that during the year 298 reciprocal registrations had been made, 33 States being involved.

The Committee on Legislation recommended that a committee be appointed to bring before the Section on Education and Legislation of the American Pharmaceutical Association the nine recommendations adopted at the Detroit meeting, with a request that they be incorporated in the Model Pharmacy Law; that uniform label requirements be adopted by all boards; that uniform requirements be adopted with respect to display of certificates of registration; and that all State laws be made uniform, and to conform with the United States laws concerning narcotic drugs.

The California pharmacists extended a most hospitable welcome to their visiting brethren and were most lavish in their entertainment. In addition to the regular reception and ball of the

President on the opening night, a special dance was given at the California Building on Wednesday evening. On Tuesday evening there was a banquet at one of the leading restaurants. On Thursday evening the ladies were entertained at a card party at the Palace Hotel and the men were given a smoker. On Friday a special concert by Mrs. Rees and Ulda Waldorf at Festival Hall concluded the programme and preceded the presentation of the Exposition Plaques.

For the ensuing year the association will elect by mail, according to the by-laws, the president, vice-presidents, and members of the Council, and it is of interest to state in this connection that our fellow-member of the Philadelphia Branch, Prof. Charles H. LaWall, of Philadelphia, has been nominated for the presidency, together with Prof. Frederick J. Wulling, of Minneapolis, and Mr. C. Herbert Packard, of Boston.

For the various sections the following chairmen have been elected for the incoming year:

House of Delegates—Chairman, H. P. Hynson, of Baltimore, Md.

Commercial Interests—Chairman, R. S. Lehman, of New York, N. Y.

Scientific Section—Chairman, Wilbur L. Scoville, of Detroit, Mich.

Section on Education and Legislation—Chairman, Frank H. Freericks, of Cincinnati, Ohio.

Section on Practical Pharmacy and Dispensing—Chairman, Joseph Weinsten, New York, N. Y.

Historical Pharmacy—Chairman, Charles Holzhauer, Newark, N. J.

Women's Section—Chairman, Mrs. G. D. Timmons, Valparaiso, Ind.

The 1916 meeting of the association will be held in September, at Atlantic City, and it will be up to the Eastern brethren of the American Pharmaceutical Association to make the 1916 meeting of the association the banner year of its history.